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<p>(21) International Application Number: PCT/US99/22347</p> <p>(22) International Filing Date: 28 September 1999 (28.09.99)</p> <p>(30) Priority Data: 60/103,646 9 October 1998 (09.10.98) US</p> <p>(63) Related by Continuation (CON) or Continuation-in-Part (CIP) to Earlier Application US 60/103,646 (CON) Filed on 9 October 1998 (09.10.98)</p> <p>(71) Applicant (for all designated States except US): MILLIPORE CORPORATION [US/US]; 80 Ashby Road, Bedford, MA 01730 (US).</p> <p>(72) Inventors; and (75) Inventors/Applicants (for US only): STANKOWSKI, Ralph, J. [US/US]; 18 Boultswell Hill Road, Westford, MA 01886 (US). MILCETICH, John, L. [US/US]; 4770 Europa Drive, Naples, FL 34105-5640 (US).</p> <p>(74) Agent: HUBBARD, John, Dana; Millipore Corporation, 80 Ashby Road, Bedford, MA 01730 (US).</p>		
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<p>(54) Title: FILTRATION MODULE INCLUDING UNITARY FILTER CARTRIDGE-BOWL CONSTRUCTION</p>		
<p>(57) Abstract</p> <p>A filtration module is provided which includes a manifold (100), a filtration cartridge (104) and a bowl (102) that houses the filter cartridge. The filtration cartridge and bowl are connected to each other to form a unitary construction. The filtration cartridge and bowl are in fluid communication with the manifold in a manner which prevents mixing of a fluid feed to the module and a permeate removed from the module.</p>		

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FILTRATION MODULE INCLUDING UNITARY FILTER CARTRIDGE-BOWL
CONSTRUCTION

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BACKGROUND OF THIS INVENTION

The present invention relates to membrane filtration modules that are more sanitary and are easier to replace and install than presently available
10 filtration modules. More particularly, the present invention relates to membrane filtration modules formed from a filtration cartridge, retaining bowl and manifold together.

The control of particulate contaminants in a filtration process such as in the semiconductor industry requires the use of ultraclean filters having
15 membranes that remove submicron particles. It is well known that any particle that is deposited on a semiconductor wafer produces a defect when the particle is sufficiently large. Typically in the semiconductor industry, failed defects can be produced by particles as small as about one tenth of the smallest features of the semiconductor chip. Therefore, membrane filters are
20 used in every process step for producing semiconductor chips to purify both working liquids and gases.

Although many different designs have been developed for a filtration module used in an ultrapure liquid filtration, two designs are prevalent. In one module design, liquid to be filtered flows from one end of the filtration module
25 to the other hand. In this class of the filtration modules, the feed and permeate connections are located at opposite ends of the filter thereby forcing the liquid flow to move from one end to the other. This flow configuration is referred to as an in line flow configuration. These filtration modules suffer from two disadvantages. First, they are more difficult to connect to the
30 process equipment since the module is sandwiched between two sets of connections. Second, any free liquid remaining within the module quickly drains upon disconnection of the module because at least one connection is positioned at the bottom of the module.

A second filtration modular design locates all of the connections at the same end of the module. In this type of module, the feed and permeate ports are typically horizontally oriented at the top or "head" end of the module on opposite sides thereof. Due to their shape, these modules are referred to as having a T, L or U configuration. This configuration facilitates connection of the head to the remaining portion of the filtration module comprising the bowl and the filtration cartridge positioned within the bowl. In this design, the bowl and filtration cartridge comprise separate elements. Thus, when constructing the filtration module, the filtration cartridge and the bowl are separately secured to and sealed to the manifold head. In addition, upon completion of filtration the bowl and cartridge are separately removed from the head. This separate removal requires that the bowl be moved a distance substantially greater than the entire length of the cartridge in order to expose the cartridge to permit its removal. Thereafter, the exposed cartridge is removed by hand or with a hand tool. Since the filter cartridge is saturated with the liquid being filtered which is often times corrosive or toxic, the cartridge removal step presents a danger to the worker. In addition, since the bowl must be moved the length of the cartridge, the space within which the bowl and cartridge are positioned must accommodate this removal step.

It has been proposed in U.S. Patent 5,114,572 to provide a filter assembly which cooperates with a bowl to produce a filter cartridge-bowl construction which can be demounted as a single unit from a manifold. The filter cartridge is connected to the bowl by bayonet connections on the cartridge which fit into grooves within the interior surface of the bowl. This bayonet connection requires the flanges extending from the outside surface of the filter cartridge be positioned into grooves that extend vertically within the bowl and then into grooves which extend horizontally within the bowl. The connection configuration requires that the cartridge first be moved vertically into the vertical grooves and then be rotated into the horizontal grooves when mounting the cartridge into the bowl. Conversely, when it is desired to remove the cartridge from the bowl upon completion of a filtration process, the cartridge must be rotated and lifted from the bowl in a single motion. Since

removal of the cartridge from the bowl requires application of force on the fluid conduit located at the top of the cartridge, and since the diameter of this conduit is smaller than the cartridge diameter there is no leverage of the application force on the cartridge. This, in turn, requires application of
5 considerable force on the cartridge when effecting its removal from the bowl that may require the use of hand held tool. The application of a rotational force and a lifting force as a single motion increases the difficulty of separating the bowl from the filter cartridge. Separation of the cartridge from the bowl is particularly difficult when toxic or corrosive fluids have been filtered
10 by this filtration device.

Further, current designs have the cartridge seal against and be lightly (friction fit) held to the manifold. Any application of back pressure when applied to the cartridge can cause the cartridge to unseat from the manifold, rendering it ineffective for filtration.

15 Accordingly, it would be desirable to provide a filtration module construction which avoids the need to remove the filtration cartridge separately than the bowl from the manifold while permitting the filter cartridge and bowl to be removed from a manifold as a single unit. In addition, it would be desirable to provide such a construction that avoids the need for applying
20 force in a plurality of directions of movement to effect removal of a cartridge and bowl from a manifold. Such a construction would promote ease of separating the cartridge and bowl from the manifold, would eliminate the danger to the worker in removing the filtration cartridge subsequent to filtration and would reduce the space required to install the filtration module. Lastly, by
25 forming the cartridge and the bowl as a unitary structure and securing that structure to the manifold, the problem of the cartridge becoming dislodged from the manifold when subjected to back pressure is avoided.

SUMMARY OF THE INVENTION

30 In accordance with this invention, a filtration module is provided comprising a manifold, and the combination of a filtration cartridge and bowl wherein the filtration cartridge and bowl are either formed of one piece or

wherein they can be locked together to be installed and removed as one piece from the manifold. When the filter cartridge and bowl are formed from separate pieces, they are joined together by application of a force in a single direction at a given time such as force in a single direction at a given time
5 such as a force in a vertical direction. The bowl and filter cartridge are joined together by a snap fit wherein mating elements on the bowl and filter cartridge are shaped so the elements are held together by friction which requires a force to decouple the bowl and filter cartridge. This construction permits the decoupling of the filtration cartridge and bowl from the manifold in one step.
10 In one embodiment, the means for a coupling the filtration cartridge and bowl to the manifold prior to use and during use. In addition, the coupling means can be constructed so that when it is desired to remove the filtration cartridge and bowl from the manifold, the filtration cartridge and bowl can be removed as one piece of manifold.

BRIEF DESCRIPTION OF THE DRAWINGS

15 Fig. 1 is a cross sectional view of a manifold useful in that present invention.

Fig. 2 is a cross sectional view of an alternative manifold use in the
20 present invention.

Fig. 3 a is an isometric view of a cartridge construction of this invention.

Fig. 3 b is an isometric view of a bowl used in conjunction with the cartridge of Fig. 3 a.

Fig. 3 c is a top view illustrating inserting the cartridge of Fig. 3 a into
25 the bowl of Fig. 3b.

Fig. 3 d is a side cross sectional view of the bowl and cartridge of Fig. 3
c.

Fig. 3 e is a top view illustrating partially inserting the cartridge of Fig. 3
a into the bowl of Fig. 3 b.

30 Fig. 3 f is a side cross sectional view of the bowl and cartridge of Fig.
3 e.

Fig. 3 g is a top view illustrating fully inserting the cartridge of Fig. 3 a into the bowl of Fig. 3 b.

Fig. 3 h is a side cross sectional view of the bowl and cartridge of Fig. 3 g.

5 Fig. 4 is a cross sectional view of a one-piece filter cartridge-bowl construction useful in the present invention.

Fig. 5 is a cross sectional view of the construction of Fig. 4 in a bowl and including means for sealing it to a manifold it to a manifold.

10 Fig. 6 is a cross sectional view of a bowl including slots for accepting a filter cartridge construction of Fig. 9.

Fig. 7 a is a cross sectional view of an alternative bowl construction of this invention.

Fig. 7 b is a partial top view of the bowl of Fig. 7 a.

15 Fig. 7 c is a cross sectional view of a filter cartridge of this invention being positioned into the bowl of Fig. 7 a.

Fig. 7 d is a cross sectional view of the filter cartridge of Fig. 7 c fully positioned into the bowl of Fig. 7 a.

Fig. 7 e is a partial top view of the bowl and cartridge of Fig. 7d.

20 Fig. 8 is an isometric view of a filter cartridge of this invention having flanges that snap fit into a bowl.

Fig. 9 a is a partial isometric view of an inner surface of a bowl into which fits the filter cartridge of Fig. 9 a.

Fig. 9 b is a partial isometric view of an inner surface of a bowl into which fits the filter cartridge of Fig. 9 a.

25 Fig. 9 c is a side view of the cartridge of Fig. 9 a fit into the bowl of Fig. 9 b.

Fig. 9 d is a top view of the construction of Fig. 9 c.

Fig. 9 e is a side view illustrating the separation of the filter cartridge from the bowl of Fig. 9 c.

30 Fig. 9 f is a top view of the construction of Fig. 9 e.

Fig. 9 b illustrates a means for separating the filter cartridge of Fig. 9 a from the bowl.

Fig. 10 is a top view of a collar that can be utilized with a filter cartridge.

Fig. 11 is a cross sectional view of the collar of fig. 10 positioned about a filter cartridge.

Fig. 12 is a top two of the collar of Fig. 10 when opened.

5 Fig. 13 is a top view of a collar positioned about a filter cartridge.

Fig. 14 is a partial isometric view of a filter cartridge having a partial collar.

Fig. 15 is a partial side view of the collar of Fig. 14.

10 Fig. 16 is an exploded cross sectional view of a filtration module of this invention.

Fig. 17 illustrates the tightening of the filter cartridge of Fig. 5.

Fig. 18 is a cross sectional view showing the filtration module of Fig. 17.

15 Fig. 19 is a cross sectional view illustrating the removal of the filtration cartridge from a manifold.

Fig. 20 is a cross sectional view showing the alignment fins in the bowl.

Fig. 21 is planar view of another embodiment of the present invention.

Fig. 22 is a cross sectional view showing the filtration module of Fig. 21.

20 Fig. 23 is planar view of a modification of the embodiment of Fig 21.

Fig. 24 is a planar view of an additional embodiment of the present invention.

Fig. 25a is a planar, top down view of a further embodiment of the present invention.

25 Fig. 25b is a planar, side view of the embodiment of Figure 25a of the present invention.

DESCRIPTION OF SPECIFIC EMBODIMENTS

30 The present invention provides a filtration module formed of a manifold, a filtration cartridge and a bowl. The manifold provides fluid pathways for fluid feed into the filtration cartridge and permeate removal from the filtration

cartridge. The bowl provides a means of storing fluid feed to permit its introduction into the filtration cartridge or to store permeate from the filtration cartridge to be directed to the manifold and then from the filtration module. Fluid feed can be introduced into the filtration cartridge through the manifold
5 either from the outside of the filtration cartridge or from within the interior of the filtration cartridge. The fluid in the bowl adjacent the filtration cartridge can be either fluid feed or permeate. In any event, the fluid feed is introduced from a manifold into the filtration module and permeate is removed from the filtration module from the manifold.

10 The filtration module and bowl are constructed so that they are sealed with the manifold or removed from contact with the manifold as one piece. Thus, the bowl and filtration module can be formed as one piece or can be formed from two pieces which are interlocked together by moving the bowl and filter cartridge in only one direction relative to each other at a given time.
15 After the bowl and filtration module have been connected to the manifold, they are locked together so that, during use in filtering of fluid, they do not become separated.

Subsequent to a filtration, the bowl and filtration module are removed from the manifold as a single piece rather than as two separate pieces. Since
20 the bowl and filtration module are removed together, the filtration module need not be removed from the bowl. Thus, a space substantially equal to the length of the filtration module and the bowl together need not be provided. Only a space as long as substantially the length of the bowl need be provided. This permits one to install a filtration module of this invention within a smaller
25 space as compared to the space required with present filtration modules. In addition, since the filtration module is removed with the bowl, it need not be handled by a worker either by hand or with a hand tool. Furthermore, any fluid positioned between the bowl and the filtration module upon completion of filtration need not be removed. This substantially reduces the possibility of
30 contacting fluid within the bowl with a worker. Alternatively, the bowl could contain a drain for removing fluid before removal.

Referring to Fig. 1, the manifold 10 includes an inlet 12, external threads 13 for connecting the bowl and an outlet 14. Fluid passageway 16 permits introduction of feed fluid into a bowl (not shown) to the outlet 14.

Referring to Fig. 2, the manifold 11 includes a inlet 20 which is in fluid communication with a bowl (not shown) and a permeate outlet 22 which is in fluid communication with a filtration module (not shown) and a gas vent 24 sealed with hydrophobic membrane 25.

Referring to Figs 3 a, 3 b, 3 c, 3 d, 3 e, 3 f, 3 g and 3 h, the filter cartridge 26 having an outlet 32 also has flanges 35 from which extend lugs 36. The lugs as shown in the Figures are oval or ellipsiod in shape, although they can be of any shape suitable for securing the cartridge to the bowl, including circular or polygonal such as square or octogonal. The lugs 36 fit into slots 37 of bowl 39, the slots 37 are provided with a shoulder 38. As shown in Figs 3 c and 3 d, the lugs 36 are positioned into slots 37. As shown in Figs. 3 e and 3 f, the lugs are moved within slots until they contact shoulders 38. The cartridge 26 is in a position where it is not centered within bowl 39 when the lugs 36 contact shoulder 38. As shown in Figs. 3 g and 3 h, the lugs 36 are positioned at the ends 41 of slot 37 by rotating cartridge 26 so that it is substantially centered within bowl 39. As a result of this rotation, the lugs 36 are snap fit between ends 41 and shoulder 38. While a snap fit is preferred to ensure a good retention, simple interference fitting may also be used. When it is desired to separate the cartridge 26 from the bowl 39, the cartridge 26 first is rotated without an additional force in a different direction to the position shown in Figs. 3 e and 3 f to position lugs 36 past shoulder 38. The cartridge 26 then is subjected to a vertical force without an additional force in a different direction to remove the lugs 36 from the slots 37. The shape of the lugs 36 is such that they are slightly larger than the space in the slots 37 at the shoulder 38. Thus, the shoulder 38 holds the lug 36 in position within the slot by friction as a result of the lug being snap fit into the portion of the slot 37 past the shoulder 38.

Referring to Fig. 4, a one-piece filtration cartridge-bowl is shown. The filtration cartridge 26 is positioned within bowl 28. The filtration cartridge 26

includes a cartridge such as a pleated cartridge 27 surrounded by supporting ribs 29. However as the filtration cartridge 26 is sealed within the bowl 28, one may use a cartridge which has no cage as the bowl 28 itself provides the protection of the filtration cartridge 26 during use and handling. The bowl 28 includes a plurality of fluid inlets 30 through which a fluid feed is introduced into bowl 28. The bowl 28 is provided with an outlet 32 through which permeate is recovered from the filtration cartridge 26. If desired, the fluid flow can be reversed whereby fluid feed is introduced through outlet (now inlet) 32 and permeate is removed through inlet (now outlet) 30. The filtration cartridge 26 and bowl 28 can be joined together to form a single piece by any conventional means such as by molding or by the use of adhesive, thermal bonding, acoustic bonding or the like.

Referring to Fig. 5, the filter cartridge-bowl construction of Fig. 4 is shown which includes a means for securing the cartridge-bowl construction to a manifold (not shown) wherein the construction includes the bowl 28 and the filter cartridge 26. The outer flange 40 of the bowl 28 is supported by the inner flange 42 of the rotatable ring 34. The ring 34 includes threads 35 on its inner surface which mate with threads 13 on the manifold of Figs. 1 or 2. The ring 34, in turn, is supported about bowl 28 by rods 36 that are formed integrally with the bowl 28 such as by being molded thereto. By virtue of the ring 34 being supported by the rods 36, it is free to rotate in either the clockwise direction or in the counterclockwise direction. When the ring 34 is rotated in the clockwise direction and the threads 35 are in contact with the threads 13 of a manifold 10 or 11, the outlet 32 having O rings 33 thereon is raised to become sealed within outlet 15 of manifold 10 or 11 (Figs. 1 or 2). The arrangement and number of O rings used is not critical to the invention and varies from maker to maker and application to application. Since the bowl 28 and filter cartridge 26 are formed integrally, the bowl 28 and cartridge 26 are raised or lowered as a single unit when the ring 34 is rotated with respect to the manifold 10 or 11. By operating in this manner, the bowl 28 and filter cartridge 26 need not be moved relative to each other to position the filter construction of this invention in place or to remove the bowl 28 and filter

cartridge 26 from the manifold 10 or 11 (Figs. 1 and 2). Thus, the length of space to assemble or disassemble the filter construction of this invention is the length of the outlet 32 rather than the entire length of the bowl 28 or the cartridge 26.

5 Referring to Figs. 6 and 8, a construction is illustrated for joining a filter cartridge and a bowl to form an integral unit. The bowl 28 includes the ring 34 and internal threads 35. The bowl 28 also includes slots 40. The flanges 70 of filter cartridge 68 fit into slots 40 so that the flanges are snap fit to be positioned within slots 40. This positioning of the filter cartridge locks it into
10 position and permits the cartridge 68 to be moved as a unit with the bowl 28 away from or in sealing contact with a manifold (not shown).

Referring to Figs 7 a, 7 b, 7 c, and 7 e, the bowl 41 includes, on its inner surface 43 two spaced apart flanges 45 and a third flange 47 having a notch 49. A filter cartridge 51 having a flange 53 is first positioned so that
15 flange 53 is positioned between flange 47 and flanges 45 (Fig. 7 c). The cartridge 51 then is slid into the position shown in Fig. 7 d so that flange 53 having shoulder 55 is positioned so that shoulder 55 fits into notch 49 thereby retaining cartridge 51 on bowl 41. It is to be understood that two sets of the flanges shown are positioned about 180 degrees apart on the inside surface
20 43 of the bowl 42. Since the shoulder 55 is slightly larger than the slight extensions 60 surrounding the notch 49, the shoulder 55 is held in place within notch 49 by friction. Thus, the shoulder 55 is snap fit in notch 49.

Referring to Figs 9 a, 9 b, 9 c, 9 d, 9 e and 9 f the top portion 57 of filter cartridge 59 having fluid outlet or inlet 61 includes arms 65 which are snap fit
25 into slots 67 within the inner surface periphery of a bowl 69. After the arms 65 are snap fit into the slots 67, the bowl 69 and filter cartridge 59 can be sealed into a manifold (not shown) as a single unit. The flange 65 is provided with a wedge shaped element 70 secured to surface 71 and spaced apart from surface 72. When separation of the bowl 69 from the cartridge 59 is desired,
30 a hand held tool can be slid along surface 70a and under wedge 70 to bend flange 65 away from slot to effect removal therefrom.

Referring to Figs 10, 11 and 12, a collar 80 is illustrated which is utilized in conjunction with a filter cartridge free of a flange which can be snap fit into a slot of a bowl as discussed above. The collar 80 provides the advantage that it can be removed from a used filter cartridge prior to
5 discarding the used cartridge so that the collar 80 can be reused with a fresh filter cartridge. The collar 80 is provided with feed inlets 82 to the bowl 28 (Fig. 6). The collar 80 attaches to a flange 86 of a filter cartridge 84. The collar 80 is provided with flanges 88 that are fit into slots of a bowl as described above. The design of the flanges can be of any design provided
10 they produce the desired retention function. The collar 80 includes a hinge 81 so that a portion of it can be rotated to engage hook elements 83 and 85 to engage or disengage the collar 80 with or from the filter cartridge 84. Permeate is removed from the filter cartridge through outlet 81.

Referring to Figs 13, 14 and 15 an alternative collar construction is
15 shown that includes two hinges 90 and 91 as well as mating hooks 92 and 93. The collar fits about the periphery of filter cartridge 94 which includes a permeate outlet 95. The flanges 96 fit into mating slots of a bowl as described above with reference to Fig. 6.

Referring to Fig. 16, an alternative means for joining the manifold 100
20 to the bowl 102 and filter cartridge 104 is shown. The manifold 100 is provided with a flange 106 that is positioned of flange 108 of bowl 102. A sealing O ring 109 is interposed between flanges 106 and 108 to seal the interior of the bowl from the surrounding environment. A clamp 110 having a wedge shaped interior surface 112 fits over flanges 106 and 108 to force and
25 maintain the flanges 106 and 108 together. The clamp can have its ends locked together in the manner described above with reference to Figs. 12 and 13. The bowl 102 and filter cartridge 104 are of unitary construction either as one piece, two separable pieces or three separable pieces including a collar as described above.

30 Figs. 17, 18 and 19 illustrate the installation and removal of the filtration module of this invention shown in with respect to the filter cartridge-bowl construction shown in Fig. 5. As shown in Fig. 17, the threads 38 of ring 34

are contacted with the threads 13 of manifold 37. The ring 34 then is rotated counterclockwise as illustrated by arrow 39 moves the filter cartridge 26 and bowl 28 toward the manifold 37 until the filter cartridge 26 and bowl 28 are in the position relative to the manifold 37 shown in Fig. 18. This relative
5 movement is achieved by virtue of rotation of the ring 34 and because the ring 34 is supported by the rods 36. The filter cartridge 26 and bowl 28 move as a unit since the filter cartridge is locked into bowl 28 as described above with reference to Fig. 7 a. When in the position shown in Fig. 18, the permeate outlet 32 is sealed in position within permeate outlet 23 of manifold 37 by
10 virtue of the O rings 33. Fluid feed is introduced into the bowl 28 through feed inlet 25, is passed through the filter cartridge 26 and is removed through permeate outlets 32 and 23. Upon completion of filtration, the ring 34 supported by rods 36 is rotated in a clockwise direction as illustrated by arrow 41. This clockwise rotation causes removal of the permeate outlet 32 from
15 contact with the manifold 37. The filter cartridge 26 and bowl 28 are removed as a unit from the manifold 37. Thus only a distance from the top surface 43 of the permeate outlet 32 to the bottom surface 45 of the manifold 37 is needed to effect removal of the filter cartridge at the point of use rather than the distance comprising the entire length of the filter cartridge as required with
20 the filtration modules of the prior art.

Figure 20 shows another preferred embodiment of the present invention. In some applications, the cartridge is inserted into the bowl on an angle, such as is shown in Fig. 3 a to 3 h.

One or more alignment fins 200 are formed on the lower inner surface
25 201 of the bowl 202. Those fins allow the cartridge 203 to be trued in a vertical alignment as it is placed into the bowl 202. The number of fins 200 used preferably is at least from 2 to 6 with 3 being the most preferred. The fins 200 preferably are equally spaced from each other around the circumference of the inner surface 201. As shown the fins 200 are of a
30 stepped configuration with the upper portion being on angle less than that of vertical and the lower portion being substantially vertical in orientation. This preferred embodiment allows for the cartridge 203 to be easily inserted into

the housing and rest adjacent the bottom of the housing. If desired, other arrangements of fins as to angle, length, height may be used and are not critical to the invention so long as they provide adequate mounting and demounting of the cartridge from the housing.

5 Additionally, the collar feature of the present invention as shown in Figures 10-12 may be comprised of a collar that contains no hinges. Such an embodiment is shown in Figure 21. In this embodiment, the collar 210 is simply snap-fit over the end of the cartridge portion 211 to which it is attached and held in place to the cartridge by the snap-fit design. Further, the design
10 of this embodiment or the embodiment of Figures 10-12 may use the flange as shown in Figures 10-12 or it may use a bayonet or lug 212 as shown in Figure 21 as the means for attaching the cartridge to the housing. The selection of the attachment means is not critical to the invention.

 Figure 22 shows the embodiment of Figure 21 in cross section as
15 attached to the cartridge.

 Figure 23 shows a second embodiment of the snap fit design of Figures 21 and 22 wherein the portion which extends over and beyond the top of the cartridge is formed of two or more distinct portions 213 A-D.

 In a further embodiment, the attachment devices used to secure the
20 cartridge to the housing, whether they be lugs, bayonets or wings or any other design, may be mounted to any portion of the cartridge. As shown in most of the embodiments of the present invention, the flanges and attachment devices are mounted to the end cap of the cartridge. Alternatively, the attachment devices 220 may be formed on the body of the cartridge 221 itself
25 such as the sleeve portion 222 of Figure 24 or the attachment devices 231 may be formed on or attached to the cartridge adaptor 230 of Figures 25a and 25b.

 The selection of filtration media used within the filtration cartridge can be any of those commonly used in the industry. Typically, the media includes
30 but is not limited to of flat sheet membrane, spiral wound flat sheet membrane, pleated flat sheet membrane, spiral pleated flat sheet membrane, hollow fiber membrane, depth filter media such as spiral wound continuous

fiber depth filter media, sintered metal filter media, ceramic media, particulate media containing an active capture material such as resin or ceramic beads or a membrane with ligands for removing selected materials from the fluid attached to their surfaces, ion exchange media such as anion resin, cation resin or mixtures of the two alone or incorporated into a membrane structure and combinations of any of these.

This media may be formed of any material typically used in filtration such as paper, other cellulosic materials such as regenerated cellulose or nitrocellulose, glass fiber and fabric, metal such as stainless steel, nickel, chromium and alloys and blends thereof, ceramics, plastics, preferably thermoplastic materials such as polyolefins, homopolymers, copolymers or terpolymers, including polyethylene such as ultrahigh molecular weight polyethylene, polypropylene and the like, PVDF, PTFE resin, PFA, ECTFE and other fluorinated resins, particularly perfluorinated thermoplastic resins, PVC, nylons, polyamides, polysulphones, modified polysulphones such as polyethersulphones, polyarylsulphones and polyphenylsulphones, polyimides, polycarbonates, PET and the like.

Lastly, in all of these embodiments the bowl and manifold may be made of a plastic, preferably a thermoplastic including polyolefins such as polyethylene, ultrahigh molecular weight polyethylene or polypropylene, copolymers or terpolymers of polyolefins, nylons, PTFE resin, PFA, PVDF, ECTFE and other fluorinated resins, particularly perfluorinated thermoplastic resins, polycarbonates, polysulphones, modified polysulphones such as polyethersulphone, polyarylsulphones or polyphenylsulphones, any glass or other reinforced plastic or a metal such as stainless steel, aluminum, copper, bronze, brass, nickel, chromium or titanium or alloys or blends thereof.

What is claimed:

1. A filtration module which comprises a manifold, a filtration cartridge and a bowl which houses the filter cartridge,
said filtration cartridge and bowl of a construction selected from the group consisting of single piece or two or more pieces joined together by
5 being snap fit together to each other to form a unitary construction,
said filtration cartridge and bowl being in fluid communication with said manifold in a manner which prevents mixing of a fluid feed to said filtration cartridge with a permeate removed from said filtration cartridge.
- 10 2. The filtration module of claim 1 which includes an inlet for fluid feed to said bowl and an outlet for permeate from said filtration cartridge.
3. The filtration module of claim 1 which includes an inlet for fluid feed to said filtration cartridge and an outlet for permeate from said bowl.
- 15 4. The filtration module of any one claim 1, 2 or 3 wherein said filtration cartridge and bowl are formed of a single piece.
5. The filtration module of any one of claims 1, 2 or 3 wherein the filtration
20 cartridge and bowl are formed from two or more separable pieces.
6. The filtration module of any one of claims 1, 2 or 3 wherein the filtration cartridge and bowl are formed from three or more separable pieces including a collar that extends about the periphery of said filtration cartridge.
- 25 7. The filtration module of claim 6 wherein the collar contains a hinge for attaching the collar to the filtration cartridge.
8. The filtration module of claim 1 further comprising one or more slots
30 formed in the inner surface of bowl and one or more flanges contained upon the other surface of the filtration cartridge such that the one or more flanges fit

within the one or more slots when the filtration cartridge is seated within the bowl.

9. The filtration module of claim 1 wherein the bowl and filtration
5 cartridge which form the unitary construction are coupled and decoupled from the manifold as the unitary construction.

10. The filtration module of claim 1 wherein the filtration cartridge contains
one or more filtration media selected from the group consisting of flat sheet
10 membrane, spiral wound flat sheet membrane, pleated flat sheet membrane, spiral pleated flat sheet membrane, hollow fiber membrane, depth filter media, particulate media containing an active capture material, ion exchange media, and combinations thereof.

AMENDED CLAIMS

[received by the International Bureau on 29 March 2000 (29.03.00)];
original claims 1-10 replaced by amended claims 1-5 (1 page)]

1. A filtration module which comprises a manifold, a filtration cartridge and a bowl which houses the filter cartridge,

said filtration cartridge and bowl being formed from two pieces joined together by being snap fit together to each other to form a unitary construction, said bowl having one or more slots formed on the inner surface of the bowl and said filtration cartridge having one or more flanges on the outer surface of the filtration cartridge such that the one or more flanges fit within the one or more slots when the filtration cartridge is seated within said bowl,

said filtration cartridge and bowl being in fluid communication with said manifold in a manner which prevents mixing of a fluid feed to said filtration cartridge with a permeate removed from said filtration cartridge.

2. The filtration module of claim 1 which includes an inlet for fluid feed to said bowl and an outlet for permeate from said filtration cartridge.

3. The filtration module of claim 1 which includes an inlet for fluid feed to said filtration cartridge and an outlet for permeate from said bowl.

4. The filtration module of any one of claims 1, 2 or 3 wherein the filtration cartridge and bowl are formed from three separable pieces including a collar which extends about the periphery of said filtration cartridge.

5. The filtration module of claim 1 wherein the filtration cartridge contains one or more filtration media selected from the group consisting of flat sheet membrane, spiral wound flat sheet membrane, pleated flat sheet membrane, spiral pleated flat sheet membrane, hollow fiber membrane, depth filter media, and combinations thereof.

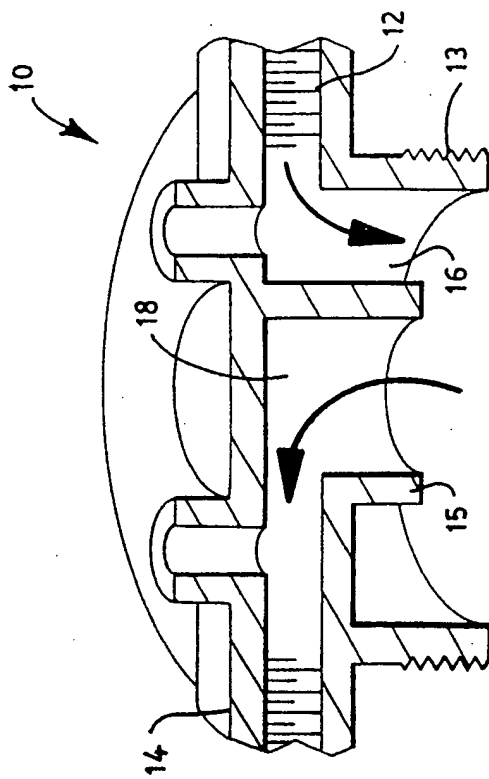


FIG. 1

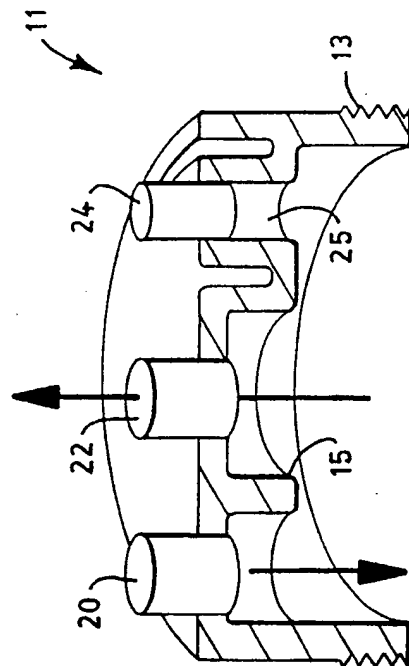


FIG. 2

2/27

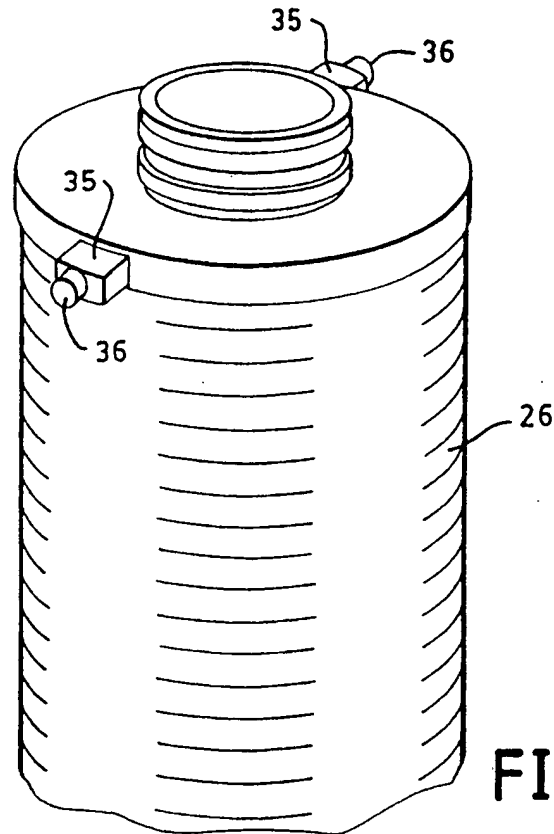


FIG. 3a

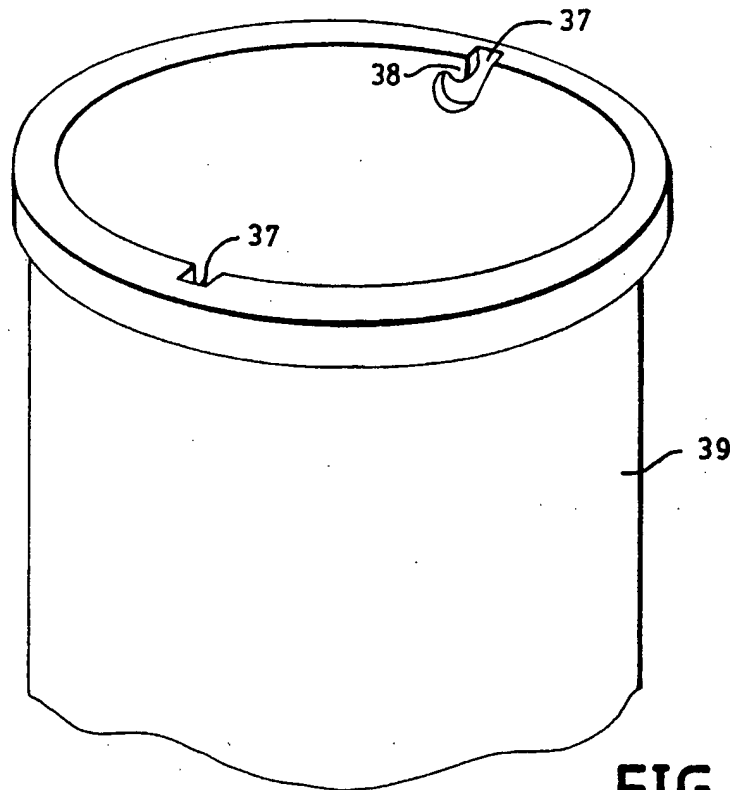


FIG. 3b

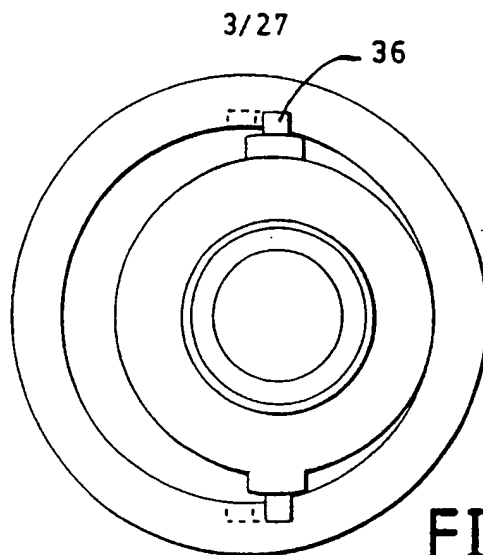


FIG. 3c

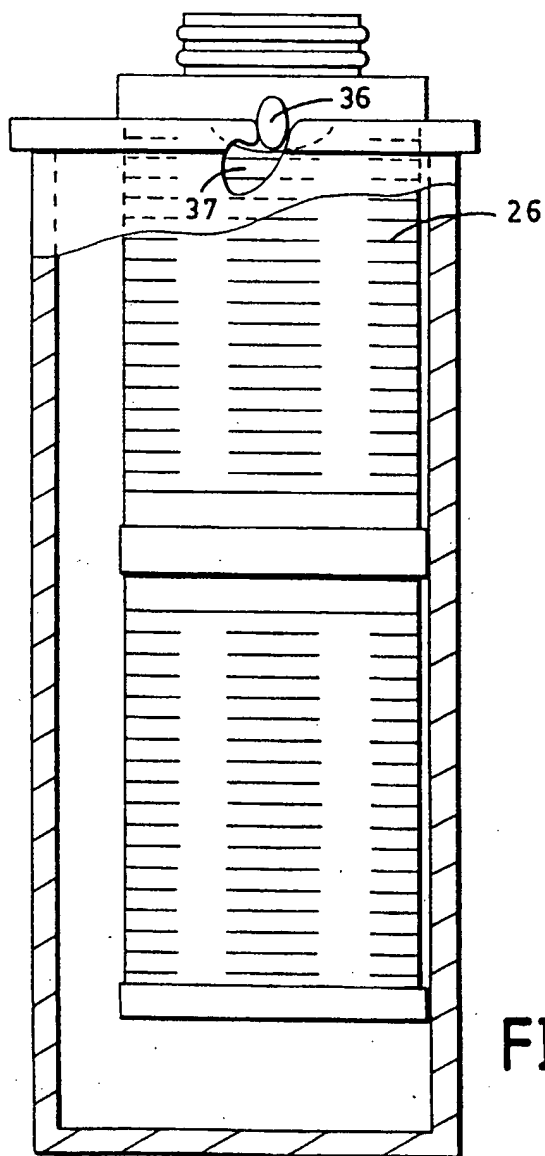


FIG. 3d

4/27

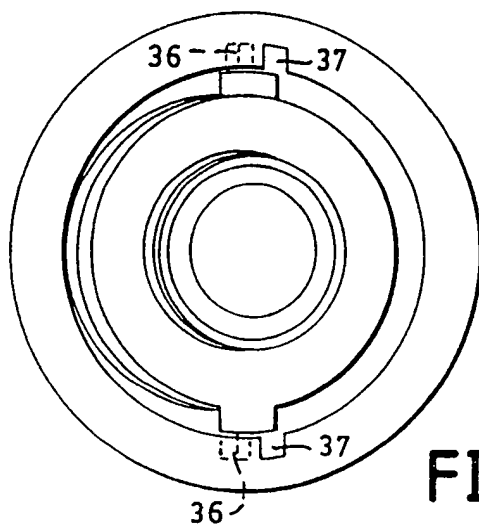


FIG. 3e

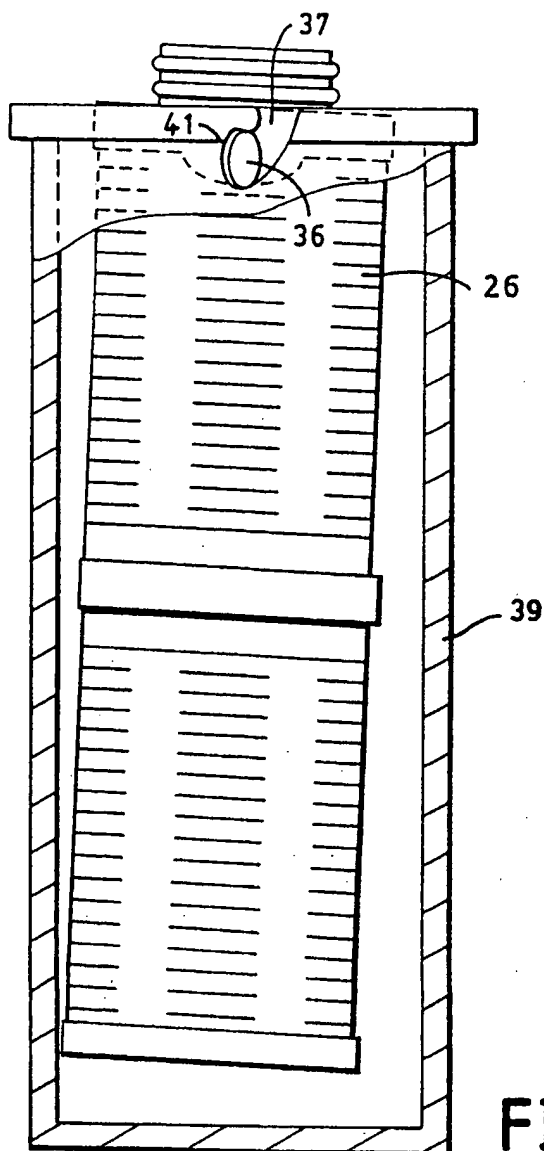


FIG. 3f

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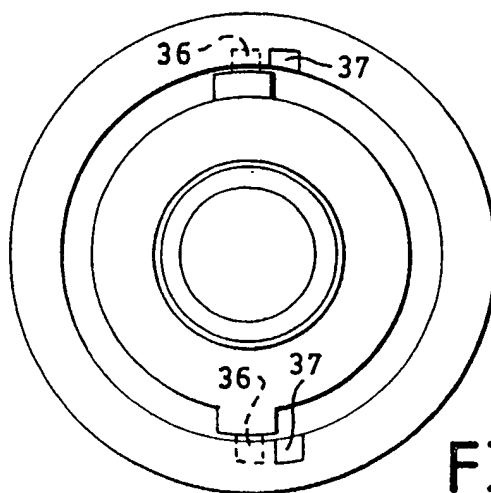


FIG. 3g

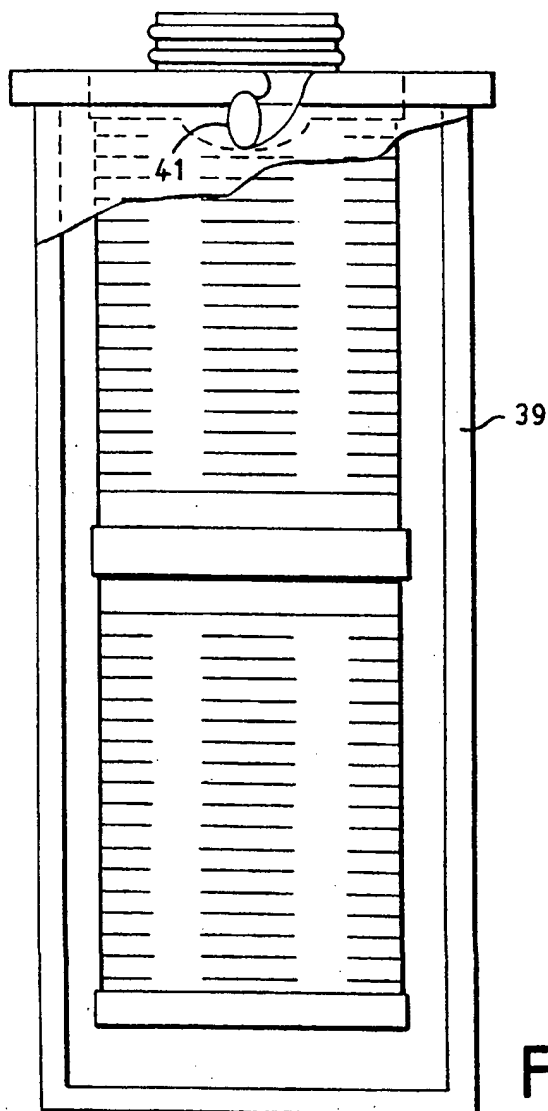


FIG. 3h

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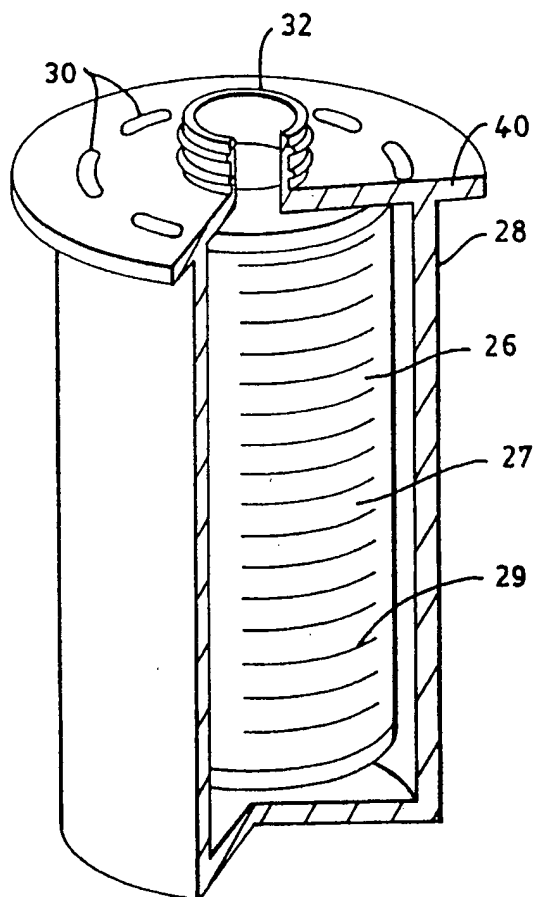


FIG. 4

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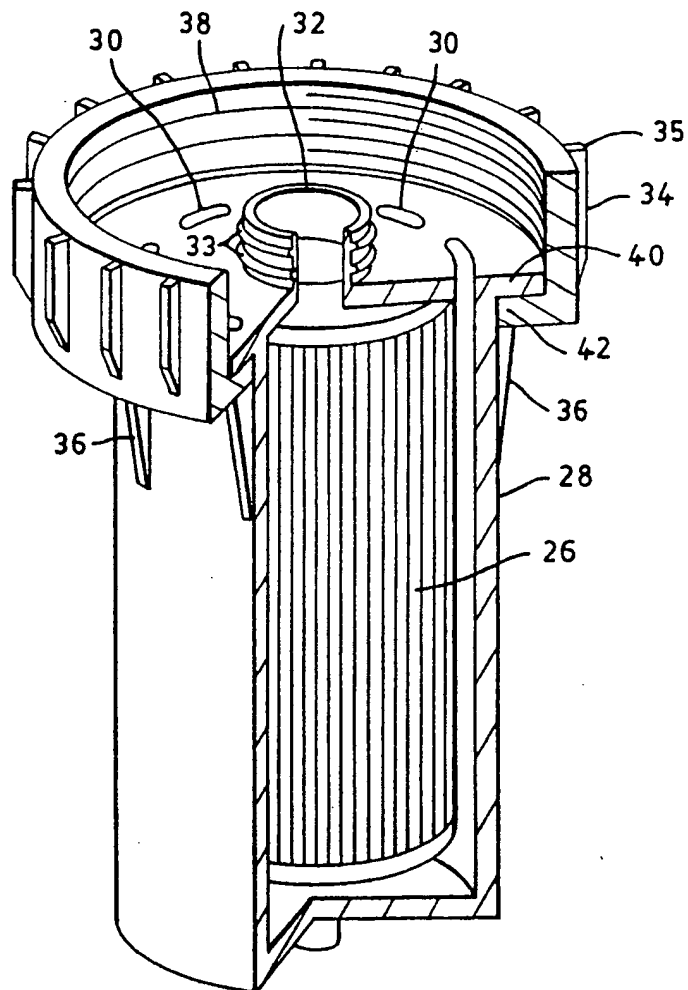


FIG. 5

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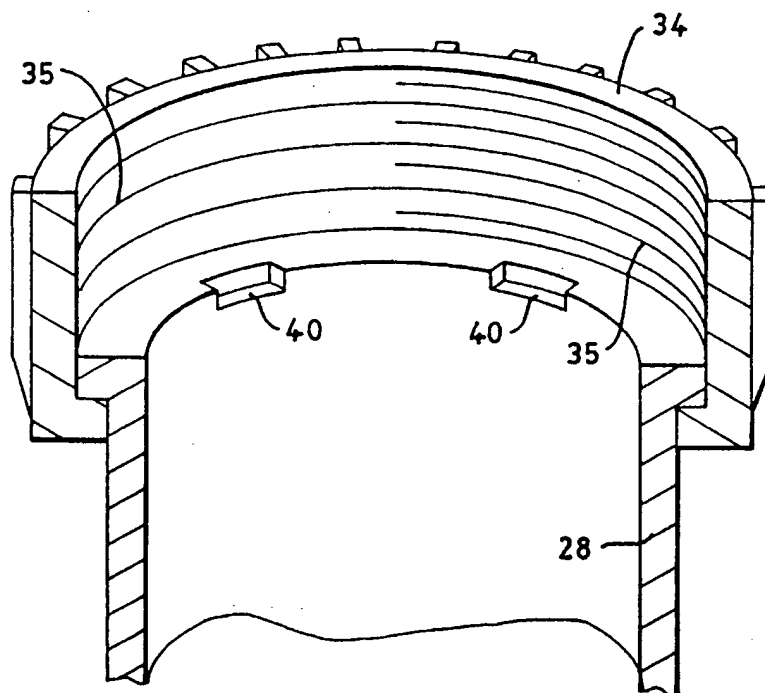


FIG. 6

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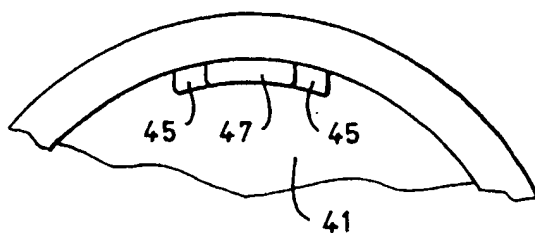


FIG. 7b

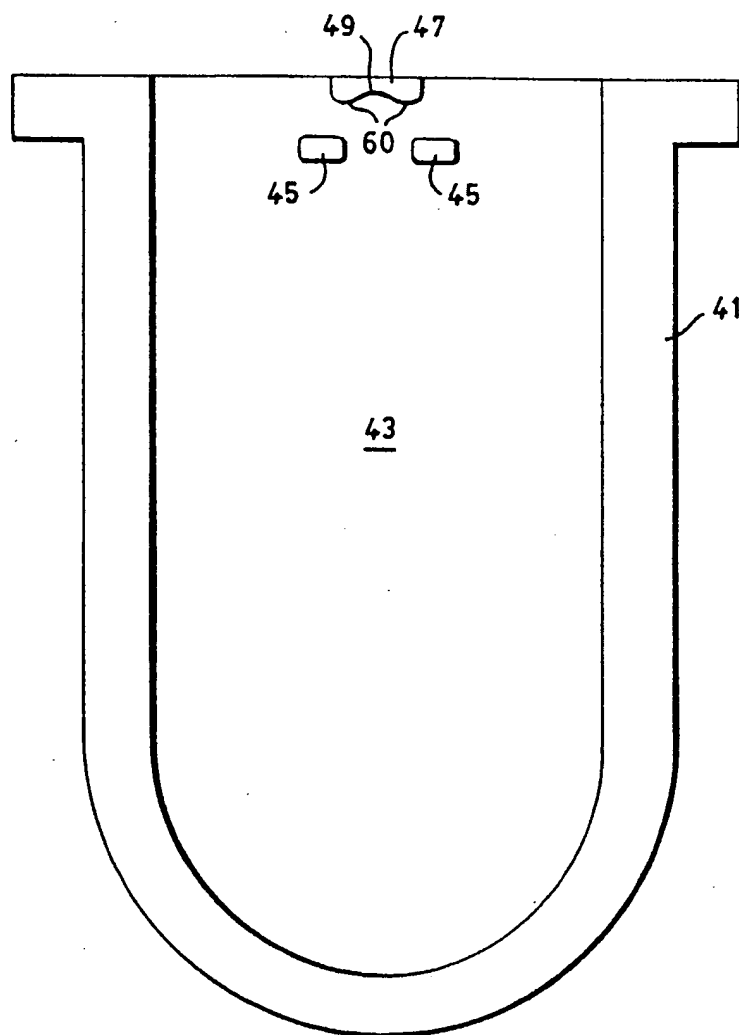


FIG. 7a

10/27

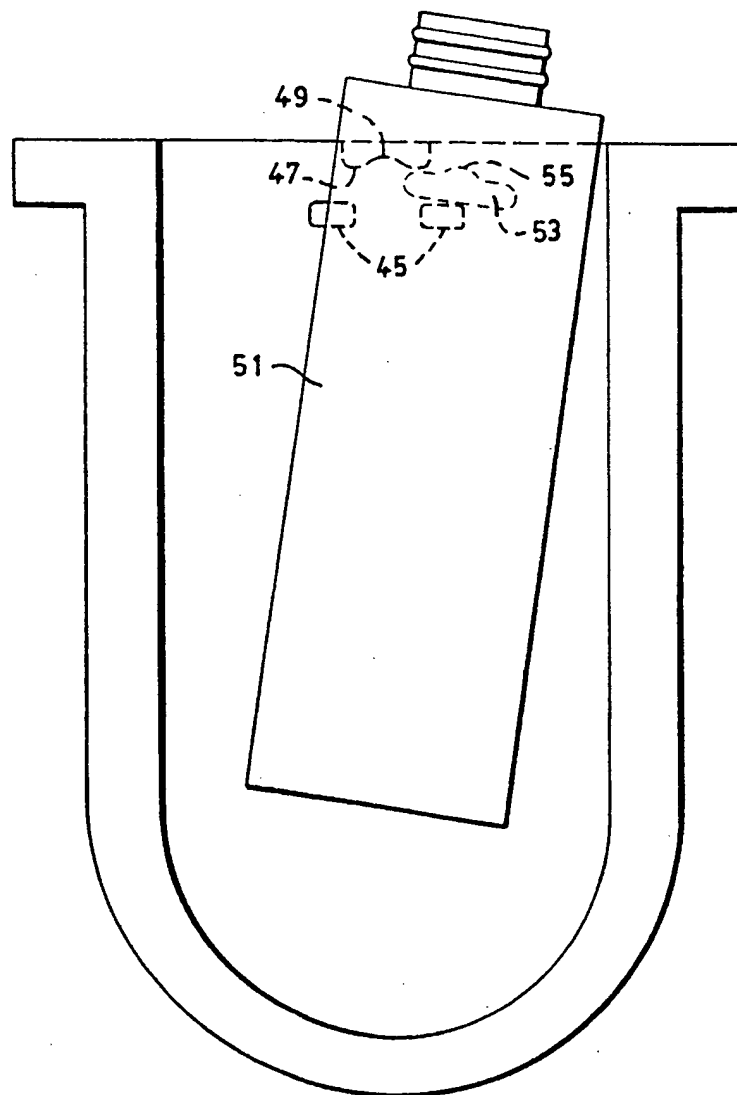


FIG. 7c

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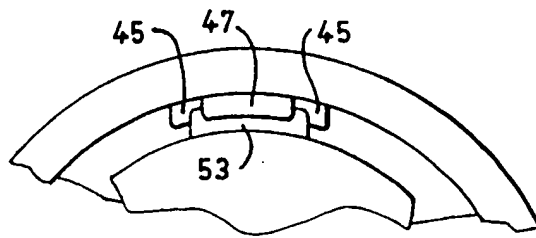


FIG. 7e

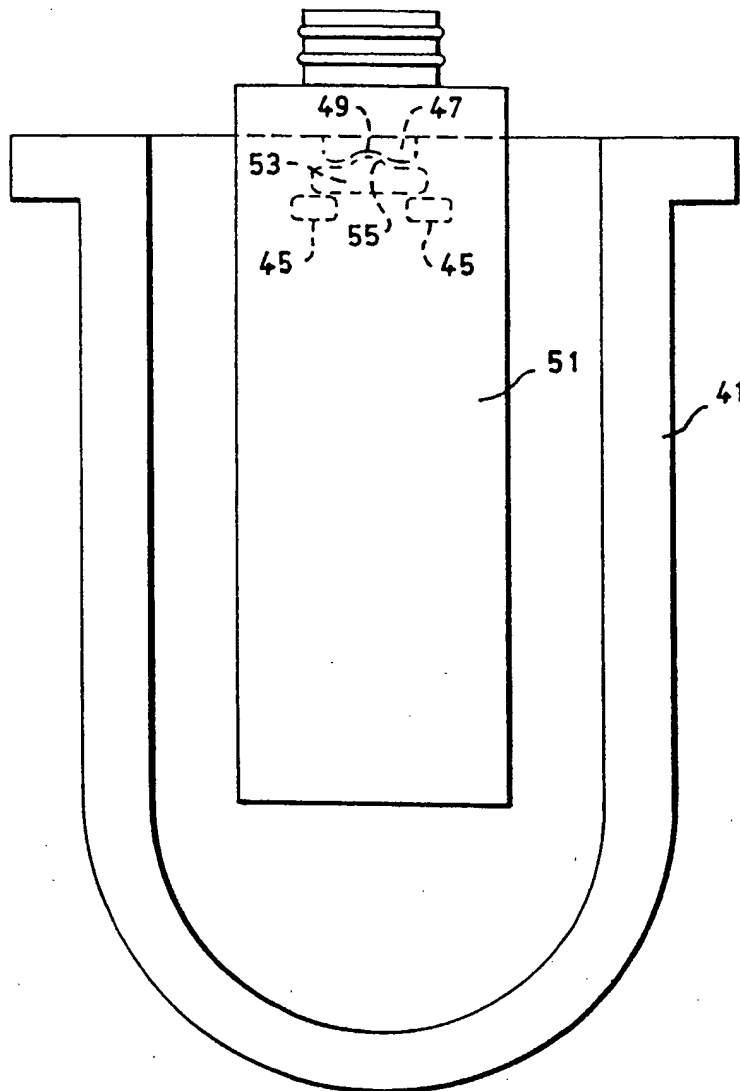
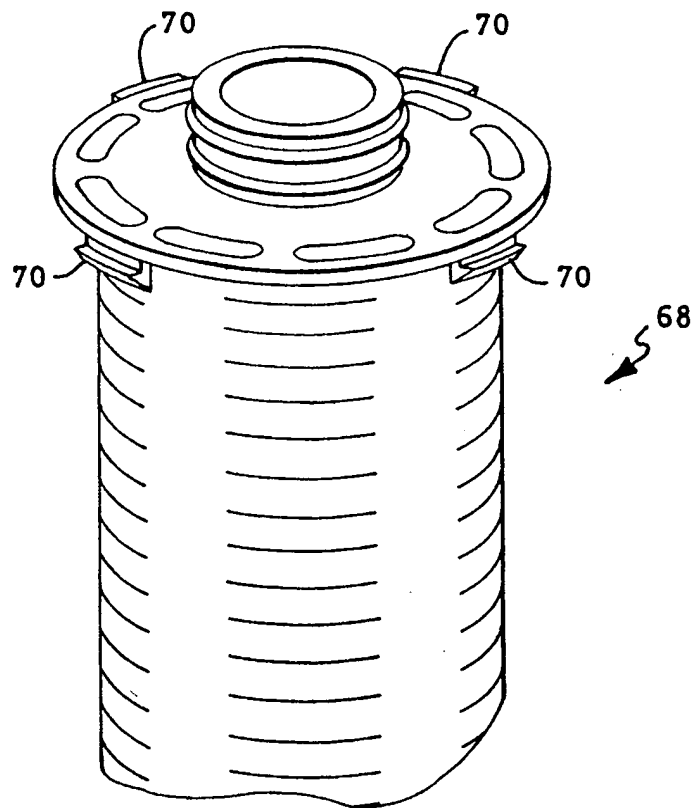
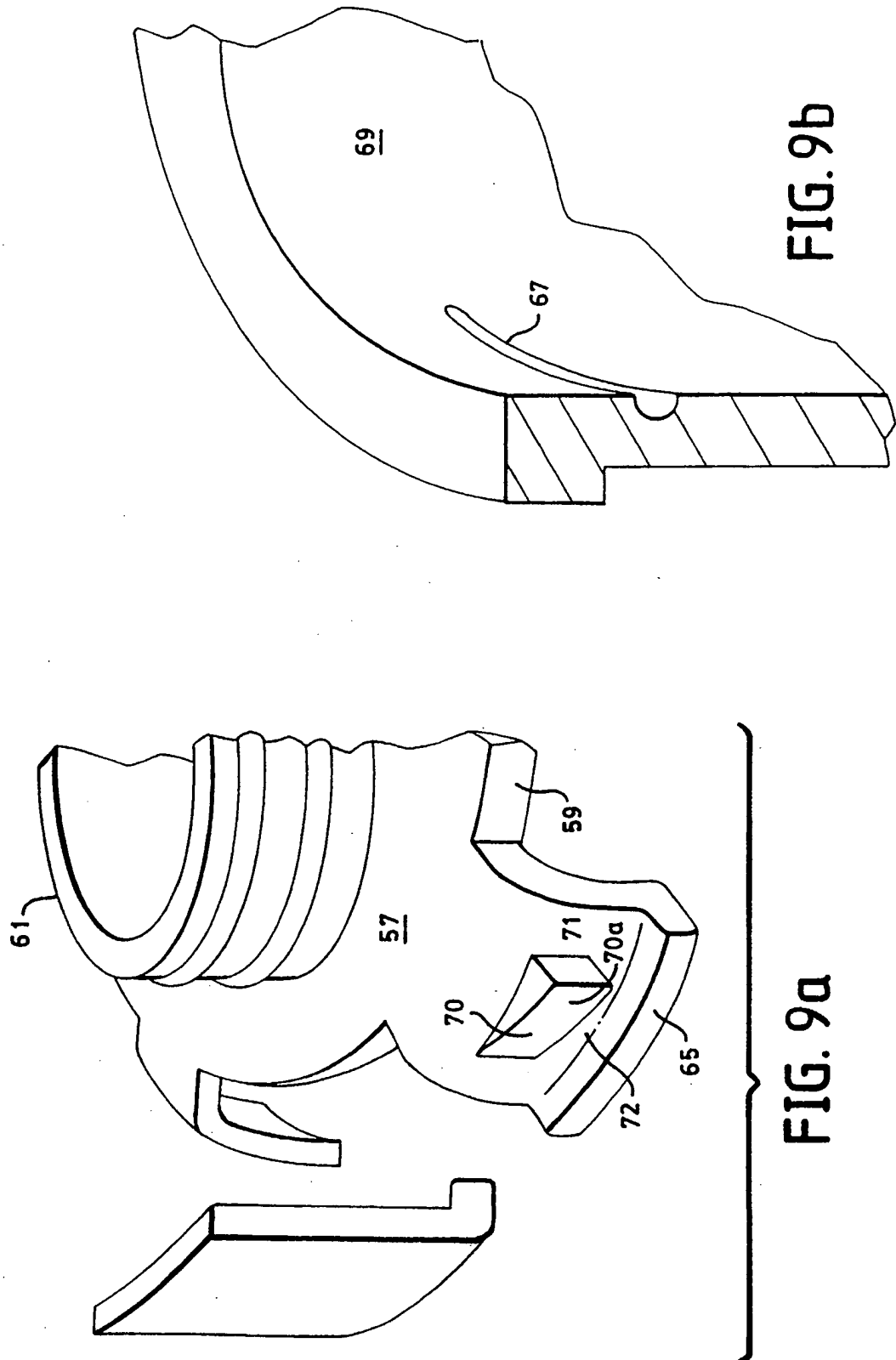


FIG. 7d

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**FIG. 8**



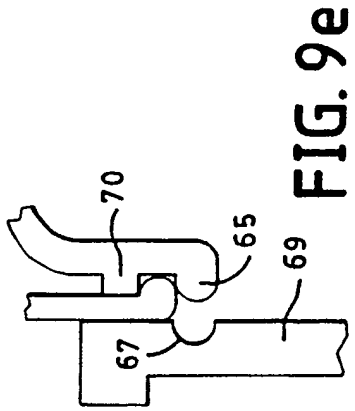


FIG. 9e

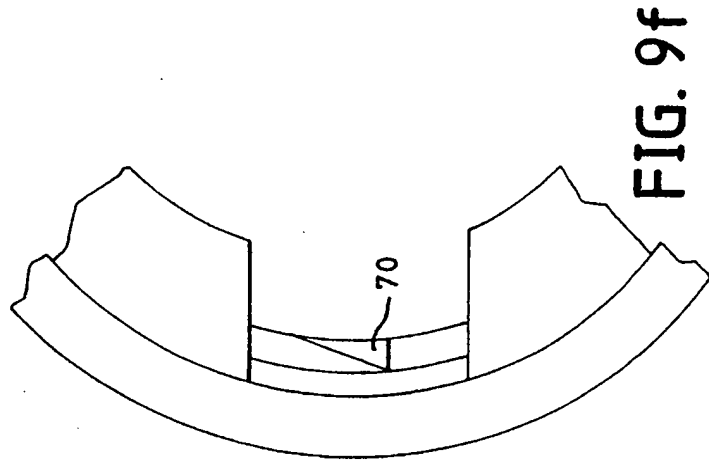


FIG. 9f

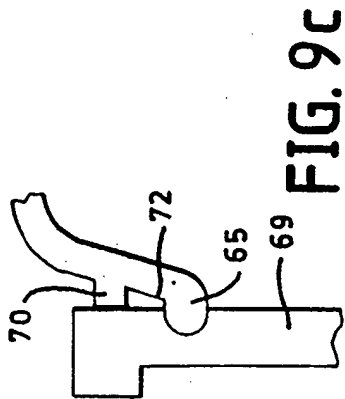


FIG. 9c

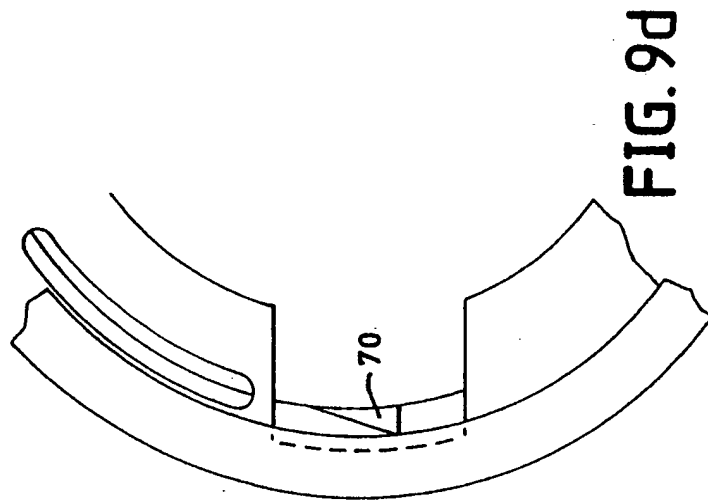


FIG. 9d

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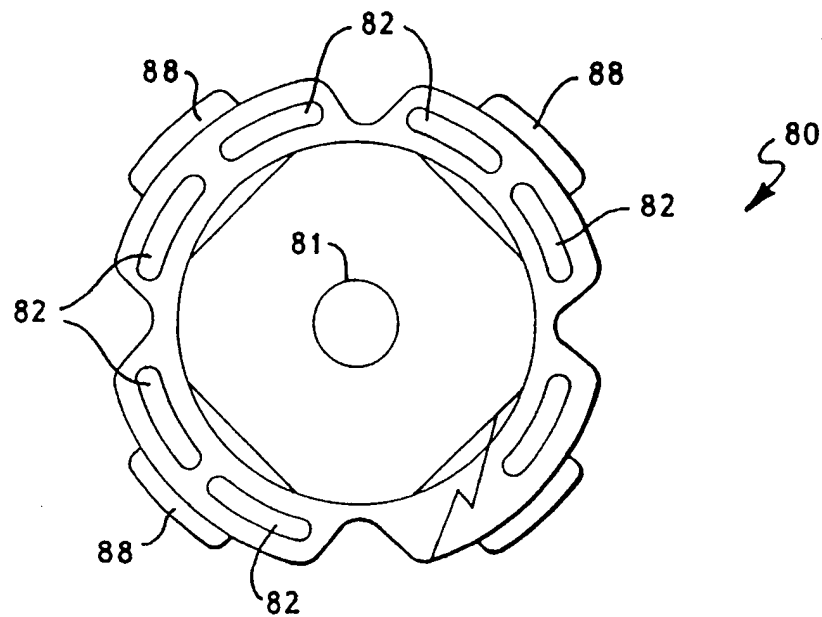


FIG. 10

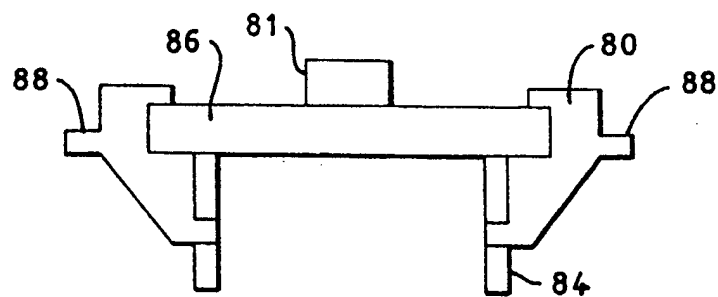
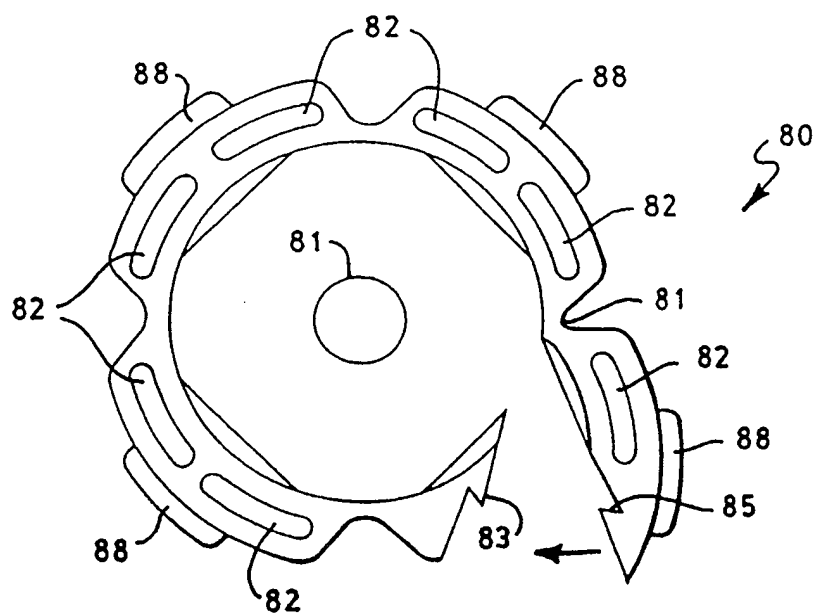


FIG. 11

**FIG. 12**

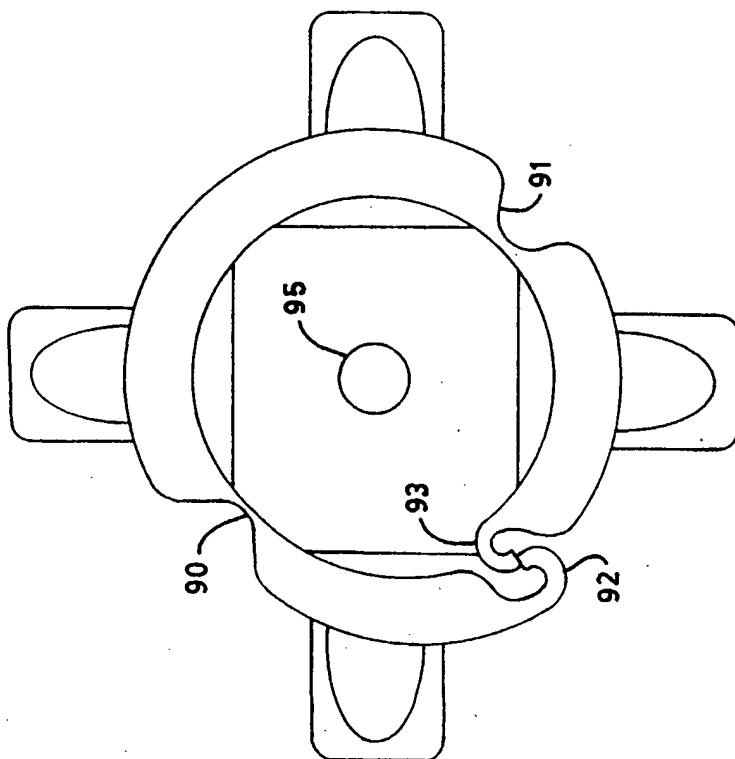


FIG. 13

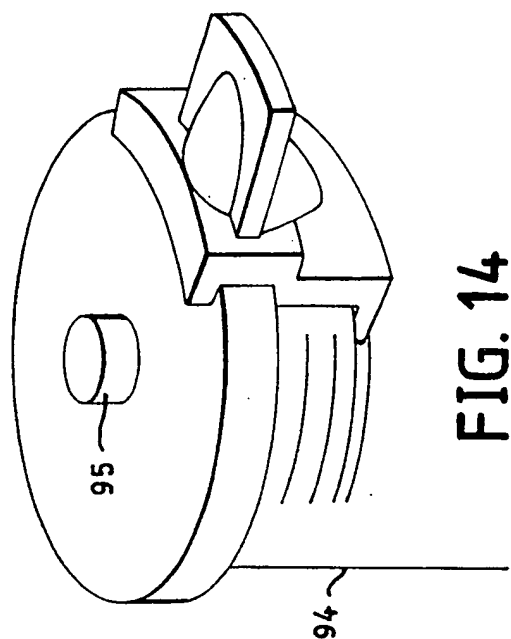


FIG. 14

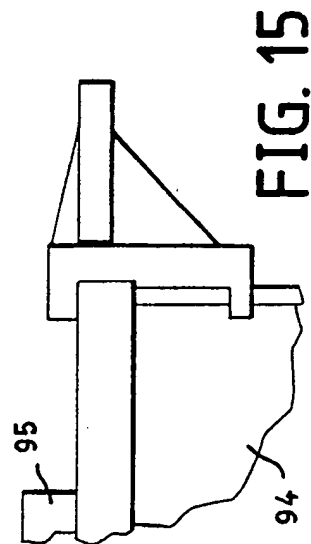
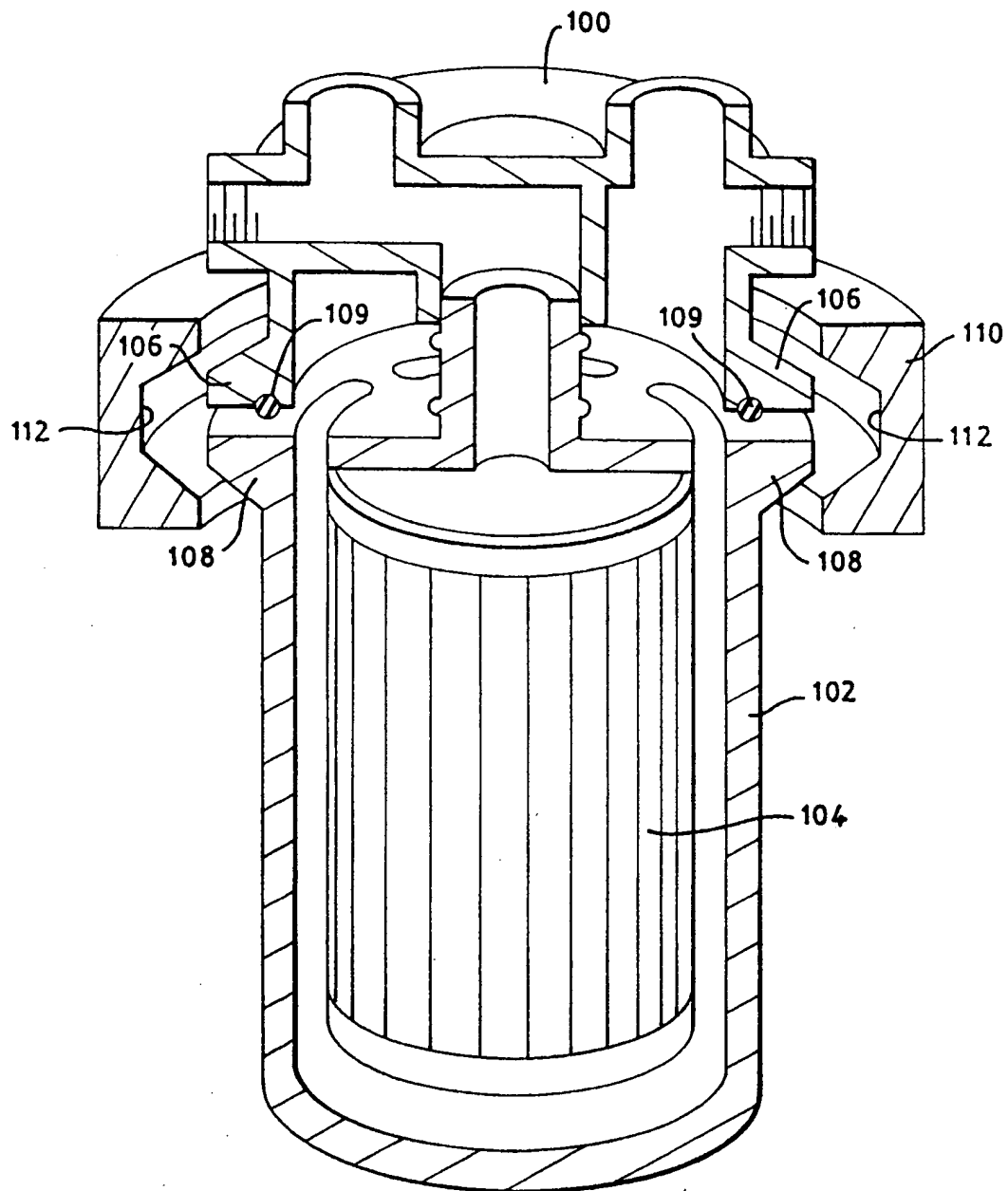
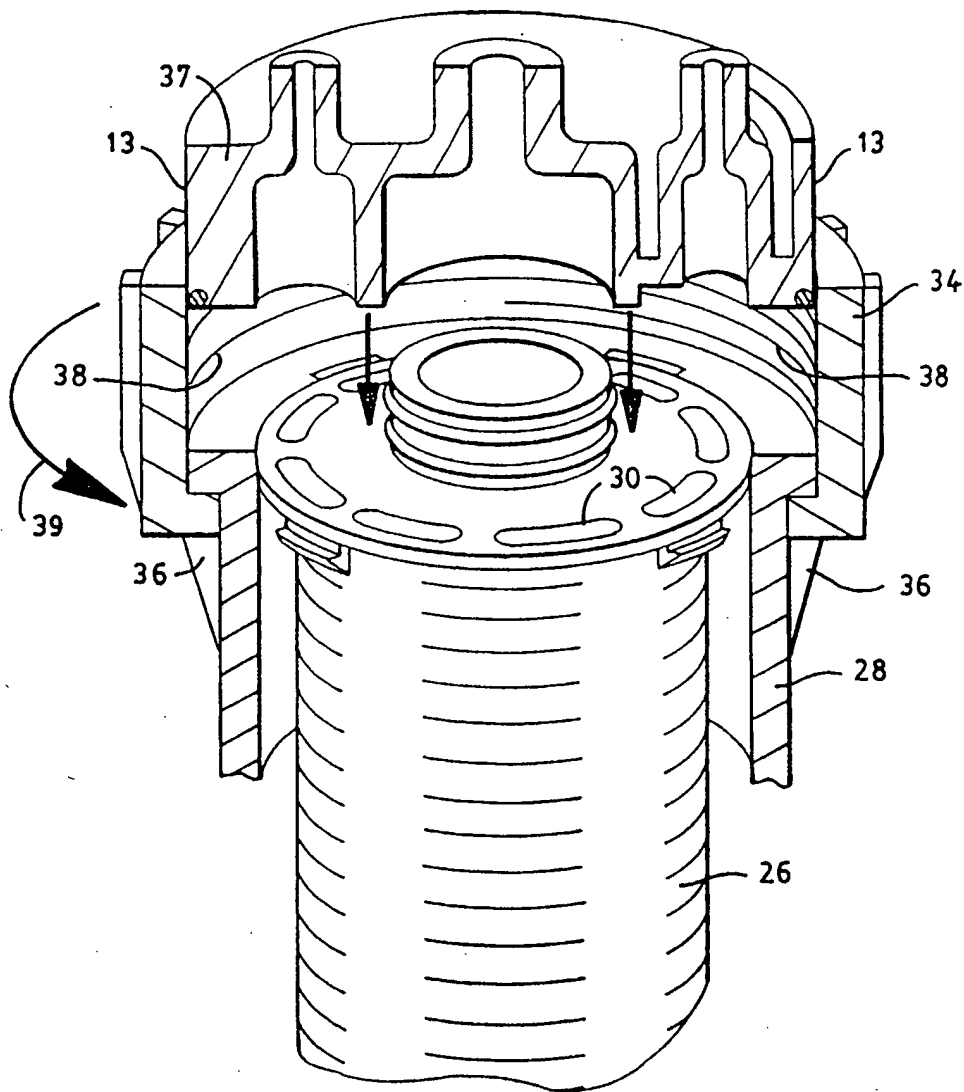
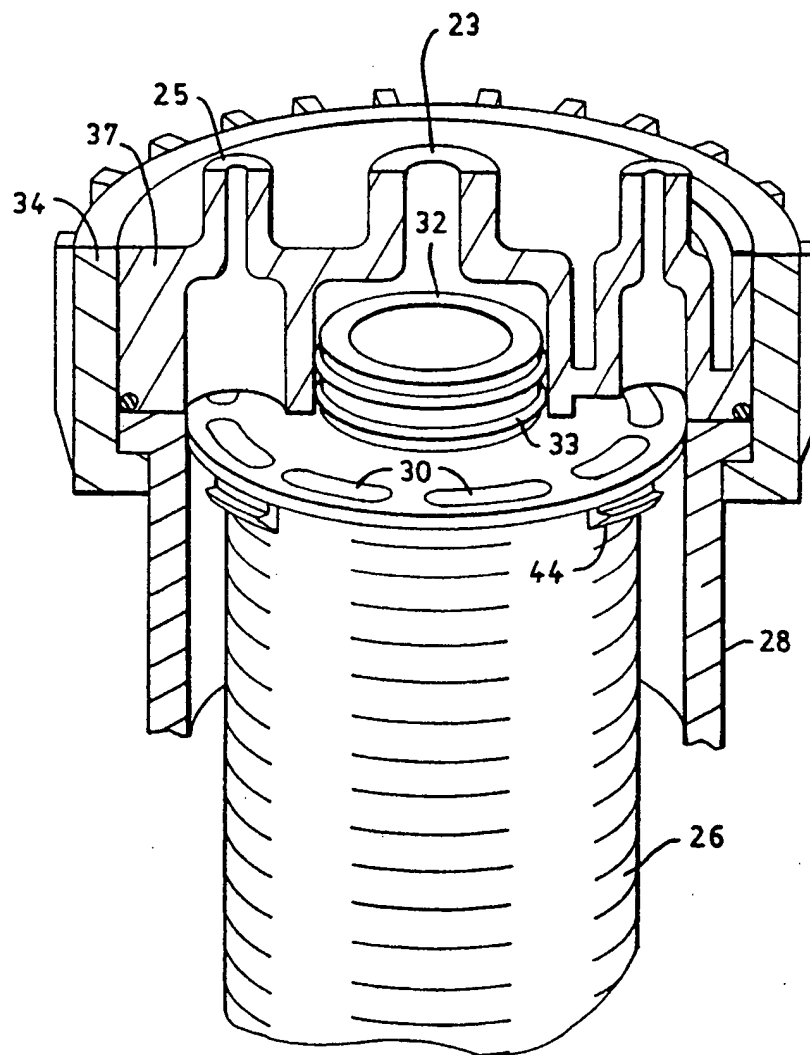


FIG. 15

**FIG. 16**

**FIG. 17**

**FIG. 18**

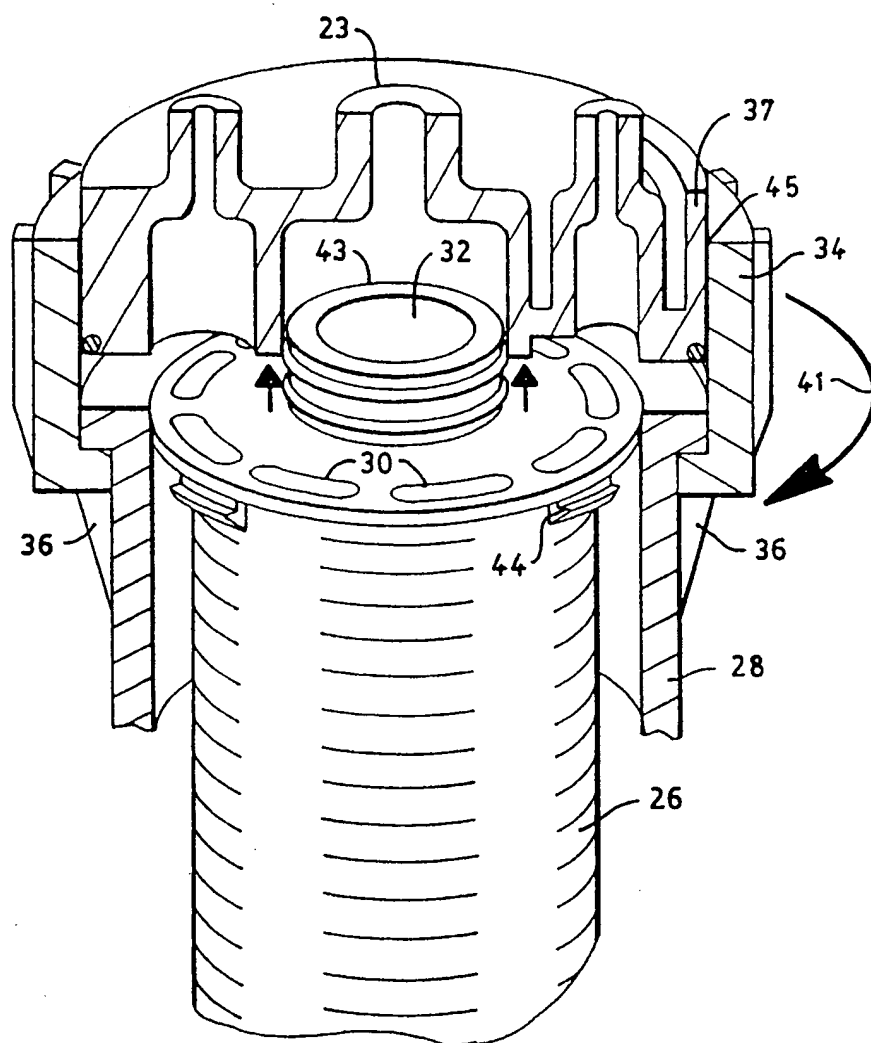
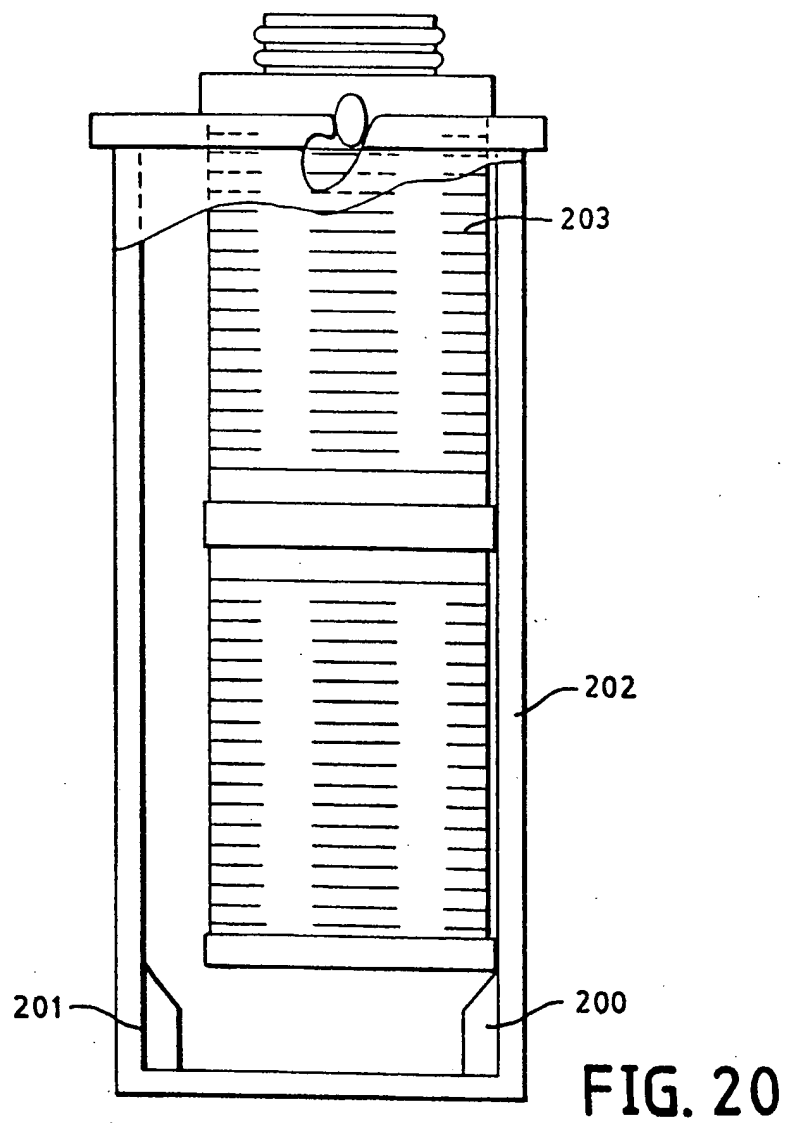


FIG. 19



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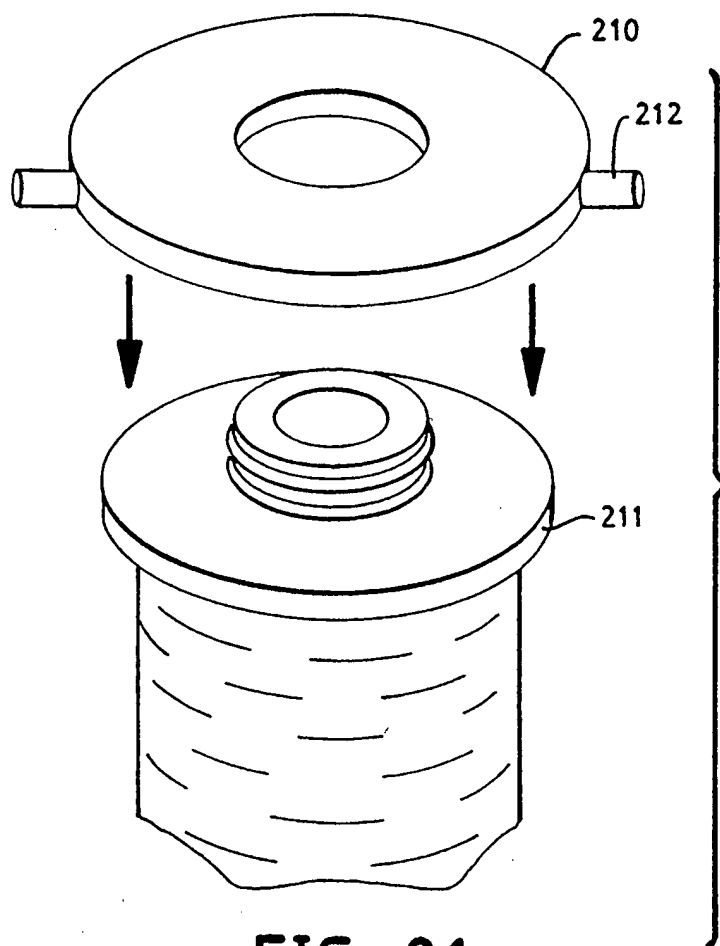


FIG. 21

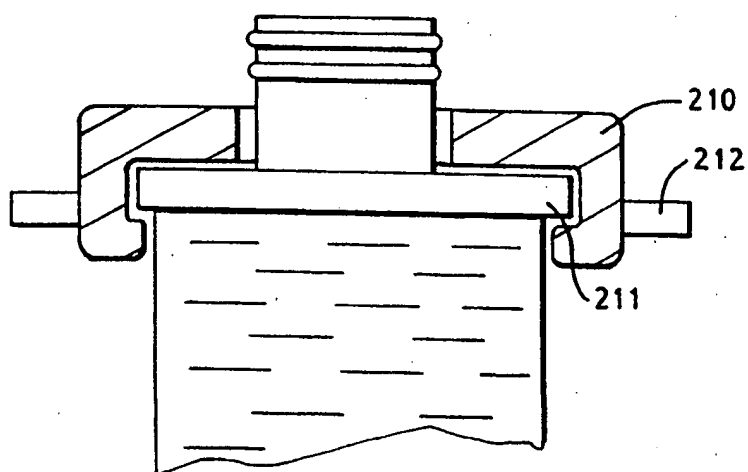
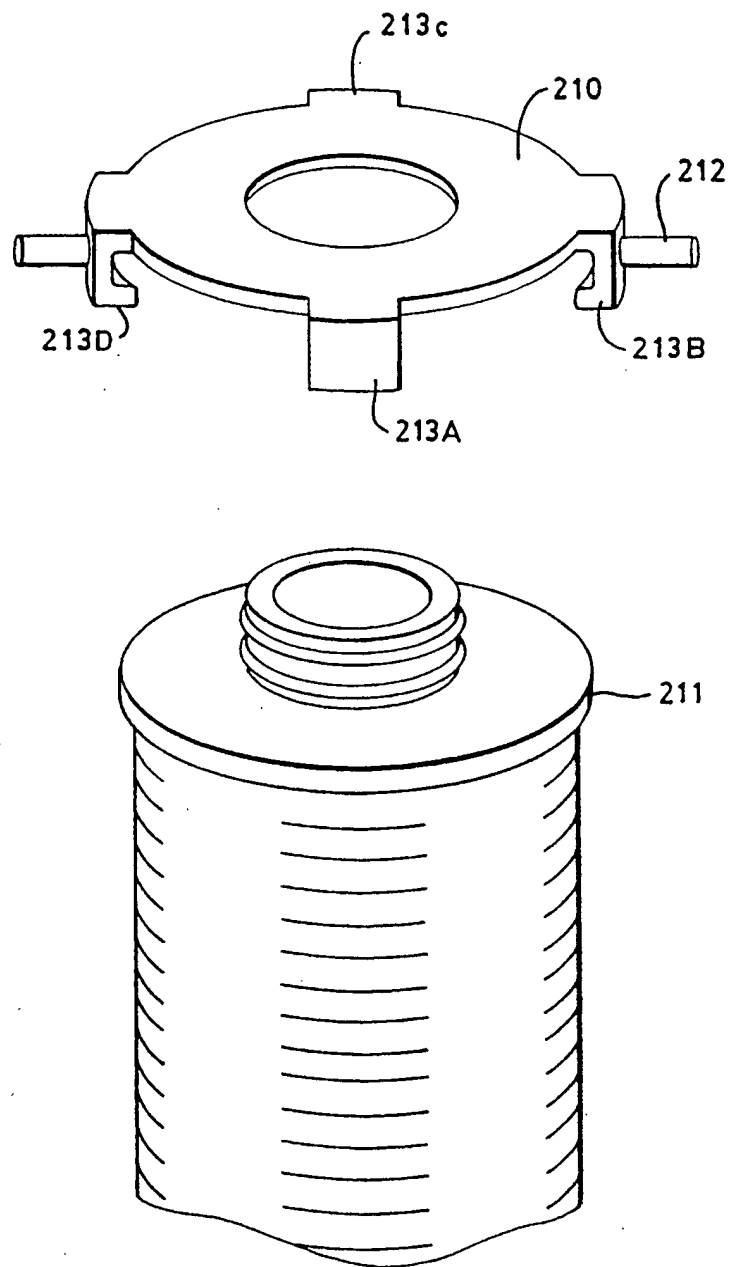


FIG. 22



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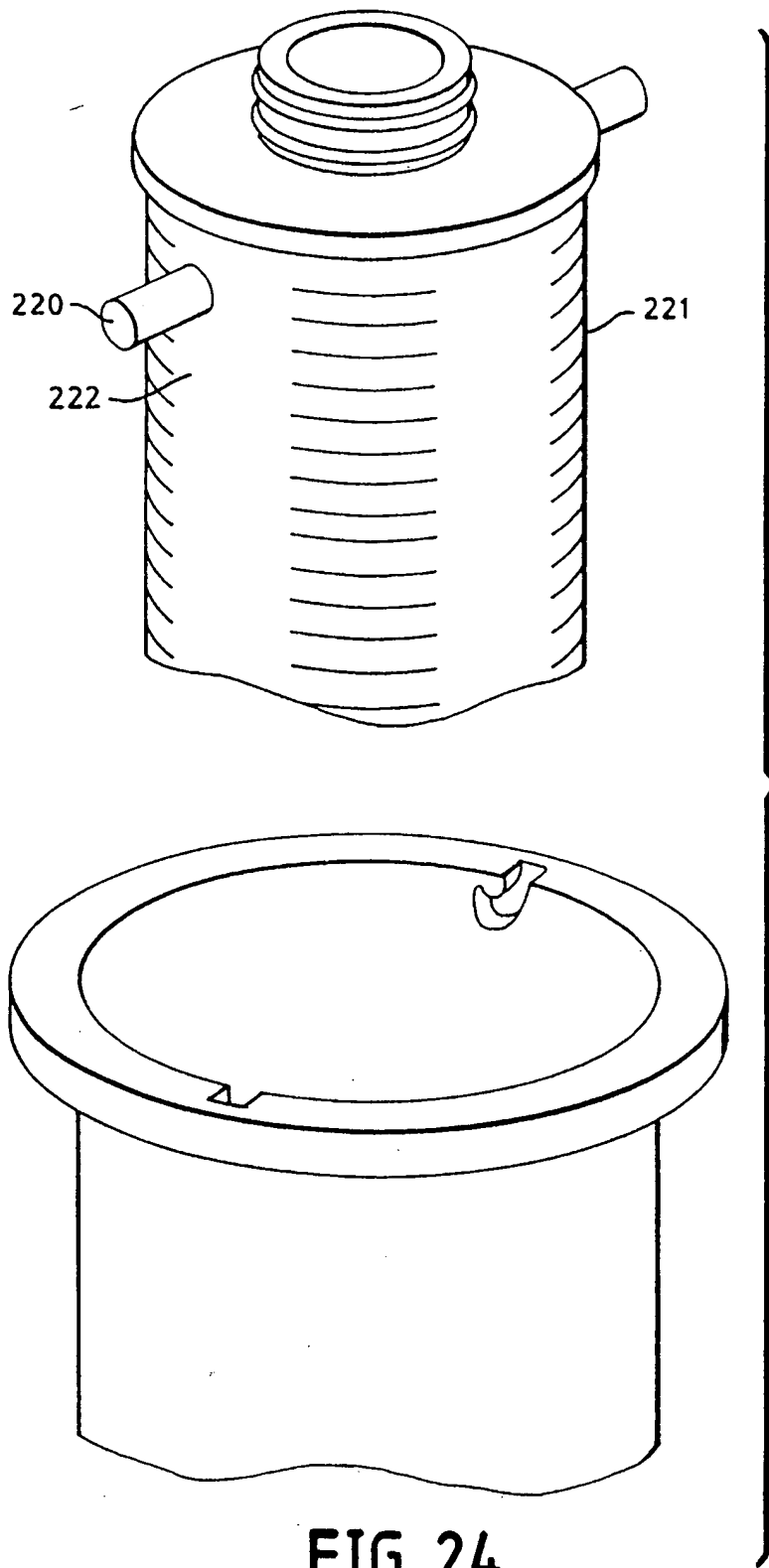
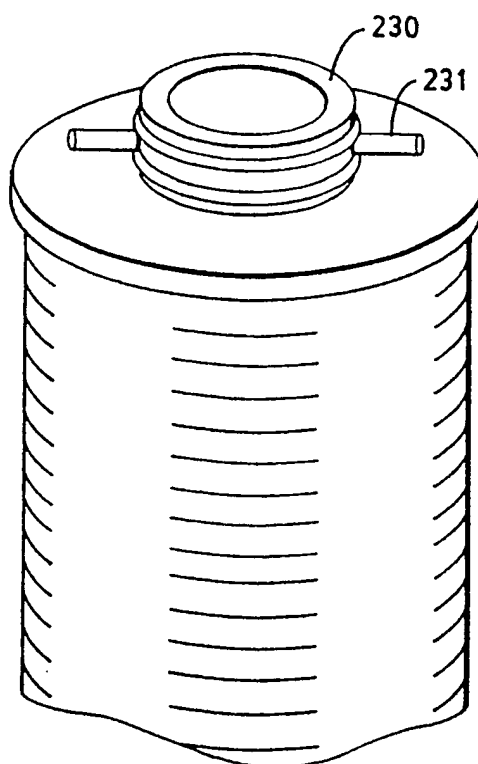


FIG. 24

**FIG. 25**

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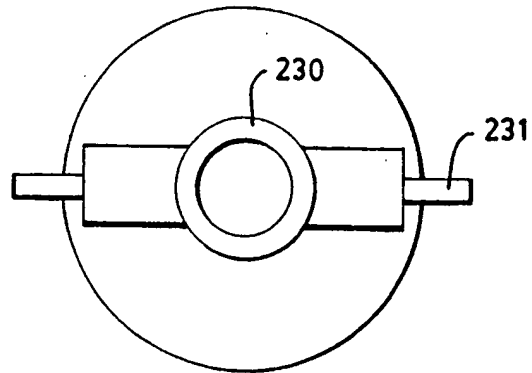


FIG. 25a

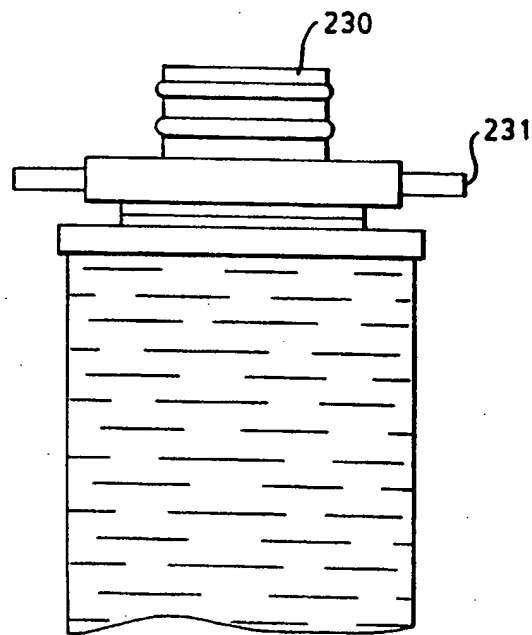


FIG. 25b

INTERNATIONAL SEARCH REPORT

International Application No.

US 99/22347

A. CLASSIFICATION OF SUBJECT MATTER
 IPC 7 B01D35/30 B01D27/08

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 7 B01D

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5 114 572 A (HUNTER GEORGE S ET AL) 19 May 1992 (1992-05-19) cited in the application the whole document ---	1-3,5,9
X	EP 0 364 299 A (EVERPURE) 18 April 1990 (1990-04-18) column 3, line 50 -column 4, line 48; claim 1; figures 4,5 ---	1-5,9
X	US 4 645 601 A (REGUNATHAN PERIALWAR ET AL) 24 February 1987 (1987-02-24) the whole document ---	1,3-5,9
X	US 5 354 464 A (SLOVAK JACK P ET AL) 11 October 1994 (1994-10-11) column 5, line 16 -column 7, line 45; figures 1-7 -----	1,3,4,9

☐ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search

24 January 2000

Date of mailing of the international search report

31/01/2000

Name and mailing address of the ISA

European Patent Office, P.B. 5818 Patentlaan 2
 NL - 2280 HV Rijswijk
 Tel. (+31-70) 340-2040, Tx. 31 651 epo nl,
 Fax: (+31-70) 340-3016

Authorized officer

Hild, U

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No

PCT/US 99/22347

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 5114572 A	19-05-1992	GB 2222534 A	14-03-1990
		DE 68918108 D	13-10-1994
		DE 68918108 T	05-01-1995
		EP 0441794 A	21-08-1991
		WO 9002597 A	22-03-1990
EP 0364299 A	18-04-1990	US 4857189 A	15-08-1989
		CA 1317235 A	04-05-1993
		DE 68911842 D	10-02-1994
		DE 68911842 T	14-04-1994
		ES 2052017 T	01-07-1994
		JP 2115008 A	27-04-1990
		US 4956086 A	11-09-1990
US 4645601 A	24-02-1987	JP 63042704 A	23-02-1988
US 5354464 A	11-10-1994	NONE	

PATENT COOPERATION TREATY

FFB - 0 2

From the INTERNATIONAL SEARCHING AUTHORITY

PCT

NOTIFICATION OF TRANSMITTAL OF
THE INTERNATIONAL SEARCH REPORT
OR THE DECLARATION

(PCT Rule 44.1)

To:

MILLIPORE CORPORATION
Attn. HUBBARD, J.D.
80 Ashby Road
Bedford, Massachusetts 01730
UNITED STATES OF AMERICA

Date of mailing
(day/month/year)

31/01/2000

Applicant's or agent's file reference

MCA-418 PC

FOR FURTHER ACTION

See paragraphs 1 and 4 below

International application No.

PCT/US 99/22347

International filing date
(day/month/year)

28/09/1999

Applicant

MILLIPORE CORPORATION et al.

1. ☒ The applicant is hereby notified that the International Search Report has been established and is transmitted herewith.

Filing of amendments and statement under Article 19:

The applicant is entitled, if he so wishes, to amend the claims of the International Application (see Rule 46):

When? The time limit for filing such amendments is normally 2 months from the date of transmittal of the International Search Report; however, for more details, see the notes on the accompanying sheet.

Where? Directly to the International Bureau of WIPO
34, chemin des Colombettes
1211 Geneva 20, Switzerland
Fascimile No.: (41-22) 740.14.35

For more detailed instructions, see the notes on the accompanying sheet.

Docketed By:

Due Date:

Reminder(s):

Article Due:

Article Due:

Article Due:

Article Due:

Article Due:

Article Due:

Article Due:

Article Due:

Article Due:

Article Due:

Article Due:

Article Due:

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Article Due:

2. ☐ The applicant is hereby notified that no International Search Report will be established and that the declaration under Article 17(2)(a) to that effect is transmitted herewith.

3. ☐ With regard to the protest against payment of (an) additional fee(s) under Rule 40.2, the applicant is notified that:

☐ the protest together with the decision thereon has been transmitted to the International Bureau together with the applicant's request to forward the texts of both the protest and the decision thereon to the designated Offices.

☐ no decision has been made yet on the protest; the applicant will be notified as soon as a decision is made.

4. **Further action(s):** The applicant is reminded of the following:

Shortly after **18 months** from the priority date, the international application will be published by the International Bureau. If the applicant wishes to avoid or postpone publication, a notice of withdrawal of the international application, or of the priority claim, must reach the International Bureau as provided in Rules 90bis.1 and 90bis.3, respectively, before the completion of the technical preparations for international publication.

Within **19 months** from the priority date, a demand for international preliminary examination must be filed if the applicant wishes to postpone the entry into the national phase until 30 months from the priority date (in some Offices even later).

Within **20 months** from the priority date, the applicant must perform the prescribed acts for entry into the national phase before all designated Offices which have not been elected in the demand or in a later election within 19 months from the priority date or could not be elected because they are not bound by Chapter II.

Name and mailing address of the International Searching Authority



European Patent Office, P.B. 5818 Patentlaan 2
NL-2280 HV Rijswijk
Tel. (+31-70) 340-2040, Tx. 31 651 epo nl,
Fax: (+31-70) 340-3016

Authorized officer

Véronique Baillou

NOTES TO FORM PCT/ISA/220

These Notes are intended to give the basic instructions concerning the filing of amendments under article 19. The Notes are based on the requirements of the Patent Cooperation Treaty, the Regulations and the Administrative Instructions under that Treaty. In case of discrepancy between these Notes and those requirements, the latter are applicable. For more detailed information, see also the PCT Applicant's Guide, a publication of WIPO.

In these Notes, "Article", "Rule", and "Section" refer to the provisions of the PCT, the PCT Regulations and the PCT Administrative Instructions respectively.

INSTRUCTIONS CONCERNING AMENDMENTS UNDER ARTICLE 19

The applicant has, after having received the international search report, one opportunity to amend the claims of the international application. It should however be emphasized that, since all parts of the international application (claims, description and drawings) may be amended during the international preliminary examination procedure, there is usually no need to file amendments of the claims under Article 19 except where, e.g. the applicant wants the latter to be published for the purposes of provisional protection or has another reason for amending the claims before international publication. Furthermore, it should be emphasized that provisional protection is available in some States only.

What parts of the international application may be amended?

Under Article 19, only the claims may be amended.

During the international phase, the claims may also be amended (or further amended) under Article 34 before the International Preliminary Examining Authority. The description and drawings may only be amended under Article 34 before the International Examining Authority.

Upon entry into the national phase, all parts of the international application may be amended under Article 28 or, where applicable, Article 41.

When?

Within 2 months from the date of transmittal of the international search report or 16 months from the priority date, whichever time limit expires later. It should be noted, however, that the amendments will be considered as having been received on time if they are received by the International Bureau after the expiration of the applicable time limit but before the completion of the technical preparations for international publication (Rule 46.1).

Where not to file the amendments?

The amendments may only be filed with the International Bureau and not with the receiving Office or the International Searching Authority (Rule 46.2).

Where a demand for international preliminary examination has been/is filed, see below.

How?

Either by cancelling one or more entire claims, by adding one or more new claims or by amending the text of one or more of the claims as filed.

A replacement sheet must be submitted for each sheet of the claims which, on account of an amendment or amendments, differs from the sheet originally filed.

All the claims appearing on a replacement sheet must be numbered in Arabic numerals. Where a claim is cancelled, no renumbering of the other claims is required. In all cases where claims are renumbered, they must be renumbered consecutively (Administrative Instructions, Section 205(b)).

The amendments must be made in the language in which the international application is to be published.

What documents must/may accompany the amendments?

Letter (Section 205(b)):

The amendments must be submitted with a letter.

The letter will not be published with the international application and the amended claims. It should not be confused with the "Statement under Article 19(1)" (see below, under "Statement under Article 19(1)").

The letter must be in English or French, at the choice of the applicant. However, if the language of the international application is English, the letter must be in English; if the language of the international application is French, the letter must be in French.

NOTES TO FORM PCT/ISA/220 (continued)

The letter must indicate the differences between the claims as filed and the claims as amended. It must, in particular, indicate, in connection with each claim appearing in the international application (it being understood that identical indications concerning several claims may be grouped), whether

- (i) the claim is unchanged;
- (ii) the claim is cancelled;
- (iii) the claim is new;
- (iv) the claim replaces one or more claims as filed;
- (v) the claim is the result of the division of a claim as filed.

The following examples illustrate the manner in which amendments must be explained in the accompanying letter:

1. [Where originally there were 48 claims and after amendment of some claims there are 51]:
"Claims 1 to 29, 31, 32, 34, 35, 37 to 48 replaced by amended claims bearing the same numbers; claims 30, 33 and 36 unchanged; new claims 49 to 51 added."
2. [Where originally there were 15 claims and after amendment of all claims there are 11]:
"Claims 1 to 15 replaced by amended claims 1 to 11."
3. [Where originally there were 14 claims and the amendments consist in cancelling some claims and in adding new claims]:
"Claims 1 to 6 and 14 unchanged; claims 7 to 13 cancelled; new claims 15, 16 and 17 added." or
"Claims 7 to 13 cancelled; new claims 15, 16 and 17 added; all other claims unchanged."
4. [Where various kinds of amendments are made]:
"Claims 1-10 unchanged; claims 11 to 13, 18 and 19 cancelled; claims 14, 15 and 16 replaced by amended claim 14; claim 17 subdivided into amended claims 15, 16 and 17; new claims 20 and 21 added."

"Statement under article 19(1)" (Rule 46.4)

The amendments may be accompanied by a statement explaining the amendments and indicating any impact that such amendments might have on the description and the drawings (which cannot be amended under Article 19(1)).

The statement will be published with the international application and the amended claims.

It must be in the language in which the international application is to be published.

It must be brief, not exceeding 500 words if in English or if translated into English.

It should not be confused with and does not replace the letter indicating the differences between the claims as filed and as amended. It must be filed on a separate sheet and must be identified as such by a heading, preferably by using the words "Statement under Article 19(1)."

It may not contain any disparaging comments on the international search report or the relevance of citations contained in that report. Reference to citations, relevant to a given claim, contained in the international search report may be made only in connection with an amendment of that claim.

Consequence if a demand for international preliminary examination has already been filed

If, at the time of filing any amendments under Article 19, a demand for international preliminary examination has already been submitted, the applicant must preferably, at the same time of filing the amendments with the International Bureau, also file a copy of such amendments with the International Preliminary Examining Authority (see Rule 62.2(a), first sentence).

Consequence with regard to translation of the international application for entry into the national phase

The applicant's attention is drawn to the fact that, where upon entry into the national phase, a translation of the claims as amended under Article 19 may have to be furnished to the designated/elected Offices, instead of, or in addition to, the translation of the claims as filed.

For further details on the requirements of each designated/elected Office, see Volume II of the PCT Applicant's Guide.

PCT

INTERNATIONAL SEARCH REPORT

(PCT Article 18 and Rules 43 and 44)

Applicant's or agent's file reference MCA-418 PC	FOR FURTHER ACTION see Notification of Transmittal of International Search Report (Form PCT/ISA/220) as well as, where applicable, item 5 below.	
International application No. PCT/US 99/ 22347	International filing date (day/month/year) 28/09/1999	(Earliest) Priority Date (day/month/year) 09/10/1998
Applicant MILLIPORE CORPORATION et al.		

This International Search Report has been prepared by this International Searching Authority and is transmitted to the applicant according to Article 18. A copy is being transmitted to the International Bureau.

This International Search Report consists of a total of 3 sheets.



It is also accompanied by a copy of each prior art document cited in this report.

1. Basis of the report

- a. With regard to the **language**, the international search was carried out on the basis of the international application in the language in which it was filed, unless otherwise indicated under this item.



the international search was carried out on the basis of a translation of the international application furnished to this Authority (Rule 23.1(b)).

- b. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international search was carried out on the basis of the sequence listing:



contained in the international application in written form.



filed together with the international application in computer readable form.



furnished subsequently to this Authority in written form.



furnished subsequently to this Authority in computer readable form.



the statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.



the statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished

2. ☐ **Certain claims were found unsearchable** (See Box I).

3. ☐ **Unity of invention is lacking** (see Box II).

4. With regard to the title,



the text is approved as submitted by the applicant.



the text has been established by this Authority to read as follows:

5. With regard to the abstract,



the text is approved as submitted by the applicant.



the text has been established, according to Rule 38.2(b), by this Authority as it appears in Box III. The applicant may, within one month from the date of mailing of this international search report, submit comments to this Authority.

6. The figure of the drawings to be published with the abstract is Figure No.

16

as suggested by the applicant.



None of the figures.



because the applicant failed to suggest a figure.



because this figure better characterizes the invention.

Box III TEXT OF THE ABSTRACT (Continuation of item 5 of the first sheet)

A filtration module is provided which includes a manifold (100), a filtration cartridge (104) and a bowl (102) that houses the filter cartridge. The filtration cartridge and bowl are connected to each other to form a unitary construction. The filtration cartridge and bowl are in fluid communication with the manifold in a manner which prevents mixing of a fluid feed to the module and a permeate removed from the module.

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 B01D35/30 B01D27/08

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 B01D

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5 114 572 A (HUNTER GEORGE S ET AL) 19 May 1992 (1992-05-19) cited in the application the whole document	1-3,5,9
X	EP 0 364 299 A (EVERPURE) 18 April 1990 (1990-04-18) column 3, line 50 -column 4, line 48; claim 1; figures 4,5	1-5,9
X	US 4 645 601 A (REGUNATHAN PERIALWAR ET AL) 24 February 1987 (1987-02-24) the whole document	1,3-5,9
X	US 5 354 464 A (SLOVAK JACK P ET AL) 11 October 1994 (1994-10-11) column 5, line 16 -column 7, line 45; figures 1-7	1,3,4,9

☐ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

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Date of the actual completion of the international search

24 January 2000

Date of mailing of the international search report

31/01/2000

Name and mailing address of the ISA

European Patent Office, P.B. 5818 Patentlaan 2
NL - 2280 HV Rijswijk
Tel: (+31-70) 340-2040, Tx. 31 651 epo nl,
Fax: (+31-70) 340-3016

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Patent document cited in search report		Publication date	Patent family member(s)	Publication date
US 5114572	A	19-05-1992	GB 2222534 A	14-03-1990
			DE 68918108 D	13-10-1994
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			EP 0441794 A	21-08-1991
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US 5354464	A	11-10-1994	NONE	

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